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CONTENTS

	Page
Reform of the Machinery of Government	1
Metal Catalysis in Cellular Metabolism. By Prof. D. Keilin, F.R.S.	4
Progress in Cell Biology. By Dr. Arthur Hughes	6
Mental Hygiene for the Student and Teacher. By Dr. Clifford Allen	6
Norwegian–British–Swedish Antarctic Expedition, 1949–52. By Dr. Brian Roberts	8
Scientific Centenaries in 1950. By Eng.-Capt. Edgar C. Smith, O.B.E., R.N.	9
Selective Toxicity. By Prof. Adrien Albert	12
Obituaries:	
Mr. John H. Reynolds. By Prof. F. J. M. Stratton, O.B.E., F.R.S.	16
Mr. J. F. Marshall, C.B.E. By P. G. Shute	16
News and Views	17
Variations in the Distribution of Radioactive Phosphorus Produced by Activity in Peripheral Nerves. By Dr. G. Causey and Dr. G. Werner	21
Dynamical Stability of Anticyclones. By R. W. James	22
Sylvicultural Treatment of Tropical Mixed Deciduous Forest. By Prof. E. P. Stebbing	23
Indian Research Fund Association: Annual Report of the Scientific Advisory Board	24
Chemistry at King's College, Newcastle upon Tyne	25
Institution of Gas Engineers: Autumn Research Meeting. By H. J. Hodsman, M.B.E.	27
Letters to the Editors:	
Influence of the Environment on Number of Vertebrae in Teleostean Fishes.—Dr. A. Vedel Tåning	28
D.D.T. and 'Gammexane' as Residual Insecticides against *Anopheles maculatus* in Malaya.—R. H. Wharton and J. A. Reid	28
Growth of Mangels and Long Beet.—Dr. L. G. G. Warne	29
A Technique for Studying Infection of *Dracunculus* in *Cyclops*.—S. D. Onabamiro	31
Apical Cell of Salt Marsh Fucoids.—Shirley D. Baker	31
A Decline of Citrus Plants in Venezuela.—Prof. R. Ciferri	32
Oxidation of Catechol by Tea-Oxidase.—E. A. H. Roberts and D. J. Wood	32
Electron Micrograph of a Chromosome of *Triton*.—Mrs. M. Danon, E. Guyénot, E. Kellenberger and Prof. J. Weigle	33
Anterior Pituitary Explants of Infantile Rats Grafted in the Anterior Eye Chamber of Hypophysectomized Hosts.—Dr. Petar N. Martinovitch	33
Chemical Constitution of Slippery Elm Mucilage: Isolation of 3-Methyl D-Galactose from the Hydrolysis Products.—L. Hough, Dr. J. K. N. Jones and Prof. E. L. Hirst, F.R.S.	34
A Synthesis of Sparteine.—E. Anet, G. K. Hughes and E. Ritchie	35
Revision of the Structural Interpretation of the Reactions and Properties of Certain Derivatives of Tetrahydrocarbazole and Related Compounds.—Dr. S. G. P. Plant and Sir Robert Robinson, O.M., F.R.S.	36
A Yellow Pigment Formed from *Para*-Aminobenzoic Acid and *Para*-Aminosalicylic Acid by Various Strains of *Mycobacterium*.—Dr. R. L. Mayer and Carol Crane	37
Solar Noise and Ionospheric Fading.—Dr. R. L. Smith-Rose	37
Ionosphere and Weather.—The Rev. E. Gherzi, S.J.	38
Relief of Internal Stresses by Precipitation.—L. M. Clarebrough	39
Elasticity and Rupture of Concrete and Stone at Constant Rates of Loading.—R. Jones	39
An Equal-Stepped Tuning in a Ganda Harp.—Dr. K. P. Wachsmann	40

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REFORM OF THE MACHINERY OF GOVERNMENT

ONE of the merits of the lectures on freedom under the law which Lord Justice Denning delivered last autumn at the Senate House of the University of London is that they view from a fresh angle certain questions of vital importance in the re-orientation of government and in the exercise of Parliamentary control. The publication of the lectures will enable a wider circle than those who attended them to study the principles he lays down (see *Nature*, December 31, 1949, p. 1101). These principles, indeed, should help to correct some of the muddled thinking which has been apparent on many occasions when the structure of the organisation of government has come into question, to which it is probably fair to attribute the partisan and political feeling which has been allowed to embitter and to confuse the discussion of what is essentially a non-party matter and demands, above all, a scientific approach if all the relevant factors are to be appraised objectively.

The complexity of this problem of the most appropriate organisation of government is obvious, whether we approach it at the level of the Cabinet, at that of parliamentary or public control or at that of the training, recruitment and numbers of the Civil Service responsible for executing policy and the day-to-day tasks of central government. Any question, for example, of reducing the size of the Civil Service cannot be considered apart from the tasks which the Service is called upon to discharge, and the new functions which it is required to serve in consequence of the conscious intervention of the Government in the everyday affairs of the country. Whatever opinions may be held as to the extent to which such intervention should go in particular fields, it is widely agreed that post-war conditions demand a greater degree of government control and that much of it is likely to continue. A consideration of general policy would necessarily precede any reduction in the size of the Civil Service, and even the review of methods which is continually proceeding under the Organisation and Methods Division of the Treasury. The effectiveness of such a review in promoting a high standard of efficiency and in securing the utmost economy of man-power depends largely on the attitude of those at the top, and the support it receives from Cabinet, level. Frustration is easily caused if there is no response at that level when proposals for eliminating useless returns or forms of activity are formulated, and all the more when the larger prospects for economy in man-power are seen to lie in the proper arrangement of government departments and in their relations with the public boards and nationalized industries so as to avoid duplication of effort.

It was suggested in the debate in the House of Commons on October 26 on economic policy that some redistribution of departments might offer possibilities of economy, or even that certain departments could be abolished. That is a small point besides the re-grouping of departments to secure greater efficiency, though economy of man-power

would certainly follow from such re-adjustment. Some of the measures to that end, such as the grouping of the defence ministries under the Minister of Defence, have scarcely been promising, however sound in theory, and some fundamental thinking on the functions to be served should precede any further re-arrangements. It is easy to point to anomalies in the duties or even the existence of certain ministries: the relations of the Ministry of Civil Aviation and the Ministry of Transport, of the Ministry of National Insurance and the Ministry of Pensions, for example, might well be examined in this connexion, and the position of the Ministry of Supply in relation to the Board of Trade, or the Ministry of Town and Country Planning, at least so far as co-ordinating duties are concerned, in relation to the Home Secretary, who would seem *a priori* to be more appropriate for discharging those duties of dealing with conflicting claims which the present Minister has found so much beyond the powers of his office. There are anomalies in the responsibilities of the Ministry of Health; and the distribution of overseas responsibilities between Foreign Office, Commonwealth Relations Office and Colonial Office might appropriately be reviewed at the present time.

There is required to-day fundamental thought and re-examination on this issue comparable with that which the Haldane Committee brought to bear upon it thirty years ago. It would be reassuring to learn that the Cabinet Committee considering the machinery of government is dealing with the problem on such lines. All that has happened in this field during the past two years reinforces Dr. W. A. Robson's reasoned criticism in the *Political Quarterly* early in 1948 of the secret proceedings of that Committee, and his plea for public discussion and for impartial and objective examination of the whole subject by a committee the members of which combine exceptional ability, great experience of public affairs, disinterestedness and freedom from ministerial preoccupations. Dr. Robson then suggested that the emergence of a ministerial hierarchy and the concentration of power in the hands of five or six ministers called for reflexion. The positive conception of government is now generally accepted, but the matter of what is termed delegated legislation alone has made apparent the need for further thought about the ultimate purposes that the organisation of government is to serve. A clear conception of those purposes or ends should precede a final decision on the means by which the ends of government are to be achieved. Moreover, experience of delegated legislation alone has led to widespread apprehension that the growing complexity and scale of central administration is fraught with grave dangers to the individual—that, even in a democracy, abuse of the executive power may readily lead to tyranny and to frustration in science, art and all the cultural activities which are the glory of the Western tradition of freedom.

It is important, therefore, that any new adaptation of the organisation of government should be worked out in the light of public debate and in full awareness of the weaknesses which at present lead to injustice or dissatisfaction among different sections of the community. It is not enough even to rectify such absurdities as the persistence of minor war-time controls long after they have served their purpose. The large majority of the 21,000 persons dealt with during 1948 in magistrates' courts for breaking Defence Regulations are not criminals. Such incidents as the fining of the farmer and his wife for serving to a casual visitor a saucer of the surplus cream left on their hands from feeding calves on skimmed milk bring the law into disrespect, and it will not suffice merely to amend a stupid regulation. There must be searching inquiry into how regulations of this type are brought into being and allowed to run one day beyond the very minimum they serve the public interest.

Some attempts have been made to determine how far consultation may eliminate the risk of delegated legislation bearing unfairly on individuals, and to define the principles which should be regarded. Clearly much depends on how far the particular legislative proposals directly affect private interests and not merely the internal working of a department. Much depends, too, on the extent and variety of such private interests, and the practicability of readily ascertaining what they are and whether they have truly representative organisations. The futility of the consultative method has already been demonstrated in particular instances in connexion with the nationalized industries. Again, the scope of parliamentary and judicial review may eliminate the need for a public voice in making delegated legislation, and apart from the safeguard of delaying the effect of a particular proposal, a statute might well require a Minister to state what bodies he has in fact consulted before making his order.

There is more involved here than putting an end to the practice of administrative convenience being allowed to override personal freedom: the linking of power with responsibility, and the termination of a spreading practice of departments or individuals being allowed to be judges in their own cause, and sometimes the utilization of the services of the scientific and technical expert, may equally enter into the establishment of an appropriate procedure or code. There has been much evidence of this in recent months, and it is worth while examining it. Particularly is it desirable that this should be done under conditions where party and personal considerations can be excluded.

First, then, there is the matter of the public boards. The Lord President of the Council has consistently recognized that we have yet to find the answer to the question how such bodies as the National Coal Board can be controlled in the public interest without being hampered by detailed interference. Mr. Morrison recognizes, too, the need for experiment and has endeavoured to keep this issue clear of party clashes on the merits or demerits of particular nationalization proposals. While it may well be that there is no one method of control which can be applied uniformly to all the various boards responsible for coal, transport, electricity and gas, it is important that we should find a satisfactory answer to this question during the next few years. Nor can we

assume that the public boards formed before the War are operated altogether satisfactorily from the point of view of parliamentary control. Even the staffing of such bodies, including the remuneration of Ministers, permanent officials and members of the national boards, cannot be entirely disregarded in considering recruitment and training for the Civil Service, on which the effects of undue disparity of terms may well be serious.

In the recent debate on the work of the Coal Board, Mr. Gaitskill's sensible and thorough review contributed little towards finding an answer to this general question. Indeed his review, with its implication that the Minister must be concerned to defend the Board rather than to watch it in the public interest, brought out the same fundamental weakness in the present structure of the nationalized industries as Mr. Strachey's defence of the Overseas Food Corporation in a later debate. The evidence is uniform that the undertakings are being run by the boards and the Ministers working together, not by the boards themselves with Ministers outside watching as part of the machinery for controlling a monopoly in the public interest. Nor have any of the debates yielded evidence that the Government is thinking about the methods which might be used for public control of nationalized monopolies.

Outside Government circles there has been a considerable amount of discussion. Besides the reconsideration of the use of the Parliamentary question —and it has been urged that the latter can have a stimulating rather than a deadening effect—one proposal that has been advanced is investigation by a 'select committee', provided with an adequate staff, and a subsequent long and full debate in the House of Commons every two or three years on the basis of the committee's reports. Such a procedure would seem to offer a means of controlling the strategy of nationalized industries and other like undertakings and of applying a periodical efficiency audit without the detailed interference which would lead to a paralysing centralization. It would not, however, provide for that check on individual injustice which the Parliamentary question provides over the Departments of State, and it is at this level that further thought is desirable to meet the need which Lord Justice Denning stressed.

In the review of its programme which Political and Economic Planning issued in October 1948, an outline was given of a P E P inquiry designed to examine the relations between government and industry and to establish the criteria by which such relations may be judged. The inquiry postulates a broad acceptance of the need for common purpose in post-war Britain, and a general conviction that such a purpose cannot be achieved without some degree of guidance and positive action from the centre. It assumes, also, that during the next decade the major portion of the nation's economy will remain in private hands, and that the government will aim at the minimum degree of interference consistent with achievement of the nation's purposes; and the broadsheet points to some assumptions as to the relation between nationalized and private industry.

While the inquiry faces frankly such fundamental questions as the nature of the common purpose and of the general decisions which government has to take, the division of responsibility between government and industry for the execution of policy, the methods and machinery by which policy is drawn up in collaboration with industry, and how to ensure that the many detailed actions are duly carried out by those who have to conduct the business of industry, commerce and finance, it does not seem certain that the inquiry will touch this aspect of freedom and law which has just been stressed. It is more likely, however, to throw light upon the other problem, namely, the utilization of the scientific and technical expert. The importance of that factor in the East African groundnut scheme has been almost eclipsed by the political and personal issues; but the success of such undertakings, no less than of the National Coal Board, of the gas and transport authorities and the British Electricity Authority, depends not only on effective parliamentary control but also on our ability to provide an organisation in which the scientific and technical expert can work effectively, and make representations at the proper level in order to determine decisions of procedure and policy when necessary.

That is one aspect of a matter which the Cabinet Committee should be considering. Another aspect is related to the question of individual justice, as has been well illustrated in the debates over the Minister of Civil Aviation's rejection of a finding of the court of inquiry into the Prestwick air accident. The Attorney-General, Sir Hartley Shawcross, in his speech in the House of Commons on December 8, went a long way towards removing the real grounds for concern which Lord Pakenham had failed to remove in the House of Lords debate. Sir Hartley Shawcross maintained, and with reason, that the findings of a quasi-judicial tribunal could not be binding on a Minister; but when he conceded that the Minister's dissent should have been conveyed in the first instance to the House of Commons and that the reasons for that dissent should have been made known, he disposed of that aspect which touches the scientific and technical expert most closely.

The very multiplicity of organisations under government and semi-government control, and the increasing number of those who in some sense or other are employed by the State, make it the more imperative, as Lord Justice Denning urged, that the most meticulous care should be taken to safeguard the rights of the individual citizen.

The Attorney-General has also discussed, before the Institute of Journalists, the law of libel in connexion with the freedom of the Press, which is parallel with the freedom of the individual. The Press should have the same freedom to talk and to criticize as he claimed for himself, and Sir Hartley said further that it would be a great disservice to Parliament and to the public interest if Parliament tried to assert rights and powers which were not absolutely necessary. It may reasonably be hoped that time will be found in the next Parliament for the unspectacular business of bringing order into this branch of the law, which

is as important for the preservation of freedom as it is at present capricious.

It need not be emphasized further that with the increasing association of the man of science and technical expert in the tasks of government at every level, this is a matter of vital importance. Scientific workers cannot be expected to co-operate freely in such work if the liberty of comment and criticism, above all on matters of fact, is withheld. The detailed recommendations of the Porter Committee on the law of libel were largely directed towards giving additional protection to the responsible dissemination of facts and opinions in the public interest; and it is necessary to insist that the review of the whole structure of government, which is now overdue at all levels, carries with it as corollary legislative measures such as the reform of the law of libel, and the establishment of independent quasi-judicial or judicial tribunals to provide effective safeguards against the abuse of executive powers or the failure of central government to maintain the vital touch with the outlook and mind of the ordinary citizens whose needs it exists to serve. Remote control to some extent is unavoidable to-day, but the conditions for securing and maintaining the essential adaptability and co-operation need continuous attention; and unless they are found the new forms of organisation and new powers which the central executive authority requires may lead to the totalitarian and not to the welfare estate, and to the decay rather than the advance of science itself.

METAL CATALYSIS IN CELLULAR METABOLISM

Schwermetalle als Wirkungsgruppen von Fermenten

Von Otto Warburg. 2 Auflage. Pp. 195+4 plates. (Freiburg i.Br.: Editio Cantor G.m.b.H., 1949.) n.p.

PROF. OTTO WARBURG'S interest in different aspects of cellular respiration goes back as far as 1908. Since more than ten years prior to the publication of this book the main activity in his laboratory was transferred from the study of metal catalysis to that of other problems of cellular metabolism, in writing this book the author probably had three objects in view: to give a more adequate summary of the work carried out by himself and his co-workers; to make a general survey of the field covered by the title of the book; and to give a much-needed account of the historical development of the subject.

As an account of the work by the author and his co-workers, the book deals mainly with the period when they were actively engaged in the study of the effect of carbon monoxide on respiration, and the photochemical absorption spectrum of the "respiratory or oxygen-transporting ferment". However, to a reader who wishes to repeat their experiments or to extend them to other materials, the account given in this book, valuable as it is, can scarcely replace the two original papers, those by Warburg and Negelein (1929) and by Kubowitz and Haas (1932), which can be considered as examples of the best experimental work in this field of research. Since the theoretical and experimental aspects of this work are widely known and have already reached text-books, they need not be discussed here. The book also deals with several other problems of metal catalysis, among which one may mention the function of metals in fermentation as revealed by the inhibitory effects of certain metal-binding substances, the copper-protein nature of the phenol oxidase of potatoes discovered by Kubowitz, the interesting work by Bücher and Negelein on photodissociation of carboxy-hæmoglobin and carboxy-myoglobin, and the work by Prof. Warburg and Lüttgens, who found that *Chlorella*, chloroplasts of green leaves or even a suspension of granules obtained from disintegrated chloroplasts, reduce quinone to hydroquinone in light with the evolution of molecular oxygen. The facts that this oxygen evolution is inhibited by phenantrolin and that the inhibition is more or less completely abolished on addition of zinc or iron suggest, according to these workers, that metal catalysis plays a part in the activity of this system. The last chapter deals with the problem of quantum requirements of carbon dioxide assimilation which, although it lies outside the scope of the book, will nevertheless be appreciated by readers interested in the problems of photosynthesis.

There is no doubt that in so far as it is a review of the work of Prof. Warburg and his co-workers, this book will be very helpful to the reader in guiding him through the rich experimental material recorded in their important original publications, and in focusing his attention upon the results of the work which are now considered by Prof. Warburg as their chief contribution to the subject.

In spite of its title, the book, however, owing to several omissions, can scarcely be considered as a general review of metallo-protein catalysts. Thus, the discussion of peroxidase and catalase is confined to a critical examination of the work of Willstätter, Hennichs, Wieland and others carried out between 1918 and 1926, whereas the hæmatin nature of these enzymes and their interesting properties revealed by subsequent studies are not even mentioned. Neither is there any reference to carbonic anhydrase, although the identification of zinc as its active group established for the first time a physiological function of this widely distributed metal.

It is the author's approach to the development of our knowledge in this subject that deserves special consideration. Unfortunately, in dealing with this interesting aspect of the subject the author missed a great opportunity, and in this respect the book is disappointing. Instead of presenting the reader with a well-balanced historical account, which could undoubtedly have been one of the most instructive features of the book, the author revives his old controversies, applying to them all the vigour and skill of an experienced polemist. However, once this attitude is adopted, the desire to score a few points over his supposed opponents prevents the author from appreciating fully the real significance of their work. Moreover, the historical development of the subject outlined in the preface and more fully developed in different chapters of the book raises several points which call for a critical examination.

(*a*) Although Claude Bernard (1857) observed that in cases of cyanide poisoning the venous blood is red, one cannot ascribe to him the discovery of the specific inhibitory action of cyanide on cellular respiration. In fact, even in 1859 he had no clear view as to the mechanism of the respiratory relationship between blood and tissues, believing "that the

venous blood owes its black coloration to carbonic acid" and that "It is infinitely probable that carbonic acid of venous blood results from an oxidation which is brought about within the red corpuscle itself". It must be remembered that the absorption spectrum of oxygenated blood was discovered only in 1862 and that of deoxygenated blood in 1864, the year when the terms 'hæmoglobin' and 'oxyhæmoglobin' were introduced into the literature. Moreover, the development of the idea that the respiration of an organism is localized not in its blood but within its tissues had a long and complicated course. It began with the work of Spallanzani published in 1807 and was completed only by the work of Pflüger (1872–75), who demonstrated that respiration is an intracellular process, a view which required another twenty years for consolidation and general acceptance.

(*b*) The reader, especially of the younger generation, not familiar with the subject of charcoal–iron models, must be reminded that charcoals as they are prepared from blood or from hæmin have no more in common with hæmatin compounds than charcoal–iron prepared from Bismarck brown or safranin. The work of Prof. Warburg with Negelein and Brefeld between 1921 and 1924 on the properties of these charcoals, however interesting it was from a physico-chemical point of view, has not been very helpful in the study of the mechanism of intracellular oxidation reactions.

(*c*) Suggestions that metals form the active groups of certain oxidizing enzymes were put forward by Bertrand (1897) for manganese and by Spitzer (1897) for iron. It was also known that the respiration of cells and the activity of certain enzymes are strongly and reversibly inhibited by cyanide. But it is to Prof. Warburg that we owe the first clear formulation of the view that these inhibitory effects are due to combination of cyanide with the catalytically active metals. Although strong evidence was thus available that metal catalysis plays a fundamental part in cellular respiration and in the activity of certain enzymes, no unequivocal experimental proof could be obtained that the metal is iron. Prof. Warburg's criticism of Willstätter's work on peroxidase is therefore unjustified. Willstätter could not logically consider in 1923 that the iron forms part of peroxidase, since his purification was not advanced far enough beyond the point when all extraneous iron had been removed. Yet to reach at that time the enzyme purity even of 40 per cent was in itself an outstanding achievement, and Willstätter's work on peroxidase was the basis of all subsequent studies which have led to the elucidation of the chemical structure of this enzyme. In this respect it may be recalled that in 1928 Prof. Warburg expressed a very discouraging view as to the possibility of isolation and purification of enzymes (*Naturwiss.*, 16, 345; 1928), notwithstanding the fact that already in 1926 urease had been obtained in pure crystalline state.

(*d*) The position of Mac Munn's work (1884–87) in the history of the subject is of special interest. In fact, had his observations been recognized by his contemporaries or by generations of workers who followed, the study of the mechanism of cellular respiration, and especially the work of Prof. Warburg between 1908 and 1926, would have traced a very different and less winding course. New lines of study would have been opened up much earlier, and the workers would have been spared much unnecessary labour and discussion. Unfortunately, Mac Munn's important work was lost for more than forty years; but the events leading to the rediscovery of intracellular hæmatin compounds in 1925 did not follow the artificially reconstructed path developed in this book. Prof. Warburg's attempts to find in the literature prior to 1925 some evidence of the existence of intracellular hæmatin catalysts have not met with success. Thus, his quotation from Hans Fischer's paper of 1924: "Von der Richtigkeit der Mac Munnschen Befunde bin ich überzeugt" is taken from a paragraph which clearly shows that Fischer, on the basis of Günther's published work, believed that what Mac Munn had discovered was myoglobin. Moreover, in 1925 Fischer and Fink repeatedly stated that although porphyrin could easily be obtained from different species of yeast they failed to find in them any indication of the presence of hæmatin compounds (*Hoppe-Seyl. Z.*, 150, 243; 1925). Prof. Warburg's quotation from Harrison's paper of 1924, with the missing words added in italics, reads as follows: ". . . *and as* it is probable that oxidations in the tissue may be catalysed by organic *iron* compounds allied to hæmatin, *the smaller inhibition by cyanide would be expected*". This view was put forward by Harrison only as an attempt to explain his failure to obtain any marked inhibition by cyanide of the oxygen uptake by a mixture of oxidized glutathione and a suspension of finely divided rat muscle that had been boiled and dried in alcohol. Apart from the fact that Prof. Warburg could scarcely accept the relationship between the above system and tissue respiration, it is the high, and not low, sensitivity of tissues towards cyanide that was justly regarded by him as important evidence for the role of metal catalysis in cellular respiration.

One cannot see how such hints could lead any research worker to the study of intracellular hæmatins. It is therefore not surprising that Prof. Warburg did not make use of these or other similar hints in his lecture delivered on April 29, 1925, in which he gave an excellent account of his views on the nature of "the respiratory ferment" based primarily upon the study of charcoal–iron models and the estimation of the total iron contents of cells or tissues in relation to their respiratory activity (*Berichte*, 58, 1001; 1925).

The reader, in his attempt to understand better the aim of the author, will possibly turn his attention to a quotation from Pasteur used as the 'motto' to this book. The misleading appearance of this motto, which has recently been mistaken for a quotation from a letter of Pasteur to Berthelot, is due to its faulty transcription. In fact, it should read as follows, the missing words again being given in italics: "Comment *M. Berthelot* n'a-t-il pas senti que le temps est *le seul juge en cette matière et* le juge souverain? Comment n'a-t-il pas reconnu que du verdict du temps je n'ai pas à me plaindre?" These were the words of challenge of Pasteur to Berthelot in the course of one of their dramatic discussions which took place in the Paris Academy of Sciences on February 10, 1879. This discussion, which concluded their twenty-year-old controversy, was revived following the unfortunate publication by Berthelot of Claude Bernard's incomplete and inconclusive notes, which appeared to throw doubt upon the whole of Pasteur's work on fermentation.

One can scarcely escape the impression that had Prof. Warburg full confidence in the meaning of Pasteur's words, this book would have been written in a different spirit: as it is, this 'motto' reflects a certain feeling of disappointment. Yet the author has no reason to complain that his work has not received its due recognition.

D. Keilin

PROGRESS IN CELL BIOLOGY

Experimental Cell Research

Edited by Torbjörn Caspersson and Ludwik Monné. Supplement 1. (Proceedings of the 6th International Congress of Experimental Cytology, Stockholm, July 10th–17th, 1947.) [Pp. xi+604. (Stockholm: Wenner-Grens Institute and Albert Bonnier; New York: Academic Press, Inc., 1949.) [n.p.

THIS volume is of importance for several reasons. The Sixth International Congress of Experimental Cytology at Stockholm in 1947 (see *Nature*, 160, 443; 1947) was the first of its kind after the War; it marked the re-establishment of the necessary international contacts between biologists, and gave a résumé of the work that had been in progress in each country during and since the war years.

The appearance of this book marks the inception of a new international journal for experimental cytology, which thus begins with a supplement. The need for such a journal is deeply felt by all students of cellular biology, who would wish those responsible for this new venture every success. Prof. T. Caspersson and Dr. L. Monné have undertaken the very considerable task of editing the present volume. It is perhaps ungenerous to complain that some of its value has been lost by its appearance two years after the Congress has taken place. No doubt the editors share this view. It is likely that many of the authors of these contributions could now add much to the reports that they gave to the Congress more than two years ago.

In this volume there are more than 120 separate entries which range in subject from the chemistry of strains of tobacco mosaic virus to the transplantation of the eyes of salamanders. There will be little doubt that the most distinguished contribution is Prof. K. Linderstrøm-Lang's lecture on the profound and still obscure subject of protein synthesis. At this Congress, specially prominent were new techniques such as cell fractionation methods and electron microscopy. The latter is the subject of six papers in this volume, which well illustrate the varying fruitfulness of the application of the electron microscope to different biological material and problems. The studies on striped muscle fibres and isolated muscle proteins of Jakus and Hall are of acknowledged importance; but it may be doubted whether the pictures of smears from glioma cells in the paper by Dr. H. Fernández-Morán bear any relation to the structure of living cytoplasm. The contributions from Prof. Caspersson's own institute are limited to two short papers, one by Drs. B. Malmgren and C. G. Hedén on nucleotide metabolism in bacteria, and the other by Dr. B. Thorell on erythropœsis. The work of both has already been published elsewhere in full.

One doubts whether the width of interest of many biologists will be sufficient to induce them to read the whole of this large volume, and reports of such large Congresses might well enjoy a wider circulation if they could be split into two or even more sections, each perhaps with the major 'set-pieces' of the Congress. Though it is obvious that the use of a finer screen for the plates and better paper would have added greatly to the cost of this volume, it is greatly to be hoped that the standard of reproduction of photomicrographs in the journal proper will be a higher one.

ARTHUR HUGHES

MENTAL HYGIENE FOR THE STUDENT AND TEACHER

Psychology of Personal Adjustment

Student's Introduction to Mental Hygiene. By Prof. Fred McKinney. Second edition. Pp. xi+752+12 plates. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1949.) 36*s*. net.

THE author of this book states that it is "an accumulation of suggestions from psychological, biological, sociological and educational literature which the student may use in developing his personality with the facilities on the campus". The aim of it is to enable him to attain personal adjustment, and, by doing so, to reach adult emotional status. It is a text-book of practical mental hygiene by an experienced educational psychologist—the author is professor and chairman of the Psychological Department of the University of Missouri.

The book itself is composed of papers which can be read either separately or in sequence as chapters. The sections are devoted to such subjects as adjustment to college work; concentration, learning and thinking; personal efficiency; understanding oneself; development of personality; creative adjustment; social proficiency and leadership; affections and conventions; marital adjustment; emotional stability; self-confidence, and so on. At the end of each chapter is a list of references, about six hundred in all, and everything is adequately documented. All this must represent an enormous amount of work.

Unfortunately the book is grossly marred by an excess of Americanisms which are often unintelligible to other English-speaking readers. Such expressions as "bull-sessions", "yell-leaders" and so on are puzzling. Here is an extract from a case-history—where the worst of such are to be found—"The boy in the case had just caught a punt with his usual deftness when two ends crashed into him, hurling him to the ground". Yet, in spite of these obvious blemishes, there is a great deal of valuable material here. Much of it would be difficult for the student to unearth for himself from the literature: this is particularly so in the case of the chapters on the technique of work and the psychology of study. A certain amount of the social side is not much related to British life, and a little of the writing has a flavour of uplift which may repel some people.

It is mainly because of the style that the book does not give the impression of going very deeply into the material which, indeed, does cover a very large field. This feeling is increased by the fact that the psychological chapters deal with the student's problems mainly from the point of view of consciousness and neglect the deeper unconscious factors in maladjustment. Some of the suggestions for dealing with emotional derangements have been taken from questionnaires filled in by students and cannot be expected to be of much value. Depression, for example, is unlikely to be improved by the suggested brisk walk, and so on.

Apart from the faults which have been noticed, it is obvious that the book has been written with honest intention, and does make a real attempt to penetrate into the student's difficulties. It is well printed on good paper with adequate illustrations. The index is comprehensive and covers thirty-three pages. The binding is pleasing.

CLIFFORD ALLEN

Atomic Energy Levels

As Derived from the Analyses of Optical Spectra. Vol. 1: The Spectra of Hydrogen, Deuterium, Tritium, Helium, Lithium, Beryllium, Boron, Carbon, Nitrogen, Oxygen, Fluorine, Neon, Sodium, Magnesium, Aluminium, Silicon, Phosphorus, Sulfur, Chlorine, Argon, Potassium, Calcium, Scandium, Titanium and Vanadium. By Charlotte E. Moore. (United States Department of Commerce: National Bureau of Standards, Circular 467.) Pp. xliii+309. (Washington, D.C.: Government Printing Office, 1949.) 2.75 dollars.

THIS is the first volume of a series of three or four from the American National Bureau of Standards aimed at bringing up to date and replacing Bacher and Goudsmit's well-known "Atomic Energy States" (1932). Elements are being dealt with in order of their atomic number, and the first twenty-five elements covered in the present volume naturally include many of the most important.

A few pages of introduction give information on the layout and the system of spectroscopic notation, with tables of values of Landé g-factors, lists of predicted term-types for various iso-electronic sequences, and ionization potentials for all elements. The main tables give the designation, configuration and term energies, always expressed in cm.$^{-1}$ above the lowest term as zero. Data appear to be very complete for the elements covered, and include some references up to 1949 and some hitherto unpublished results.

This is a most valuable work, and the author and those associated with her are to be congratulated on getting through the laborious work of compiling this first volume. The scope of the book is, of course, limited. It only gives energy-levels, and for most work requiring actual wave-lengths or wave-numbers of lines it is still necessary to refer to original papers. Is it too much to look forward perhaps to the production of an even more useful volume on selected classified lines of the elements?

The present volume includes data for the elements in all known states of ionization. Indeed, more than three-quarters of the book is devoted to highly ionized atoms: this will appeal mainly to the specialist; but the work has thus at least the merit of completeness, and the inclusion of so much data has not apparently had any adverse effect on the price, which is remarkably reasonable for these 309 pages of tabular matter. A. G. GAYDON

The Human Body and its Functions

An Elementary Textbook of Physiology. By Prof. C. H. Best and Prof. N. B. Taylor. Revised edition. Pp. xi+500. (London: Chapman and Hall, Ltd., 1949.) 18*s*. net.

THE names of Best and Taylor on any book on physiology give assurance that it will be authoritative and well written. The present volume is a revised edition of one aimed particularly at the layman rather than the medical student. Revision has enabled the authors to include some of the more recent advances in this science. In the account of problems connected with safe blood transfusions, for example, there is a note on the *Rh* factor, now recognized as the cause of certain hitherto unexplained neo-natal deaths. The story of the vitamins is also brought up to date.

Part 1, on atoms and molecules and on protoplasm, though simply written, may make difficult reading for those with no previous scientific training; but this should not deter the reader from passing on to the rest of the book, which will be easily understandable, helped by diagrams which on the whole are good but the value of which is sometimes lessened by over-simplification.

The interest of the book is enhanced by the inclusion in some of the sections of historical details. In the excellent account of respiration, for example, history is invoked to give an explanation of the double meanings we associate to-day with the words 'inspire', 'expire' and 'inspiration'. The whole book is a straightforward account of the functions of the human body. It is written in simple and clear language, and will undoubtedly entertain and instruct the lay reader, for whom it is intended.

W. C. C.

Catalogue of Union Periodicals

Vol. 1: Science and Technology Supplement. Edited by Percy Freer. Pp. 522. (Pretoria: South African Council for Scientific and Industrial Research, 1949.) n.p.

TO the "Catalogue of Union Periodicals. Volume 1: Science and Technology", issued in 1943 for the National Research Council and National Research Board, Johannesburg (see *Nature*, **154**, 102; 1944), a Supplement has now been issued. Again edited by P. Freer, librarian of the University of the Witwatersrand, it now includes entries relating to cement, paint, perfumery, soap and plastics, and is intended largely to replace the original 1943 volume. The new volume contains 4,758 main entries and 6,363 cross-references from 97 libraries, as against 7,175 main entries and 4,273 cross-references from 77 libraries in the original volume. New entries are distinguished by an asterisk and modifications in the arrangement, for example, one alphabetical sequence for all titles dealing with the same subject, in any one language, irrespective of country of origin, and the maintenance of a constant order for language sub divisions were made in response to suggestions received. The abbreviations of the "World List of Scientific Periodicals" are again used.

Maintenance of Shade and Ornamental Trees

By P. P. Pirone. Second edition. Pp. xvii+436. (New York and London: Oxford University Press, 1948.) 32*s*. 6*d*. net.

THIS work, first published seven years ago, is a handbook for those concerned with the care of trees, and treats of many of the ills that the arboriculturist normally encounters, whether from faulty growth, pests or disease. The author is plant pathologist to the New York Botanical Garden and so writes from practical experience; the emphasis is naturally on American species and conditions, although the European grower will find much here that is useful, dealt with in simple language.

The present edition has been enlarged by a thirteen-page appendix in which brief notice is made of some of the newer insecticides such as D.D.T. and modern fungicides such as 'Fermate', as well as diseases that have assumed importance in recent years. But the most significant addition is a classified bibliography divided into sections corresponding to the various chapter subjects, which should be of considerable help to the public to whom this volume is addressed. The text is well illustrated by more than 170 figures, mostly photographic reproductions.

E. J. S.

NORWEGIAN–BRITISH–SWEDISH ANTARCTIC EXPEDITION, 1949–52

By Dr. BRIAN ROBERTS
Scott Polar Research Institute, Cambridge

THE Norwegian–British–Swedish Antarctic Expedition, for which the necessary financial backing has been fully secured, left London on November 23, 1949, for the western part of Dronning Maud Land. The initiative for the project came from Prof. Hans W:son Ahlmann, of Stockholms Högskola, when, at a meeting of the Royal Geographical Society in November 1945, he proposed an expedition to undertake modern glaciological research in the Antarctic. Six months later, in May 1946, he proposed both in London and in Oslo that it should take the form of a joint Norwegian–British–Swedish expedition, and outlined the important results which might be expected from a detailed study of those areas in Dronning Maud Land which had been discovered and photographed from the air by the German *Schwabenland* expedition in 1939. The idea aroused wide interest in all three countries, but especially in Norway, where Norske Geografiske Selskab (Norwegian Geographical Society) set up a committee early in 1947, under the chairmanship of Generalmajor Hjalmar Riiser-Larsen, to make plans for an expedition to sail in the autumn of 1948. Riiser Larsen's plans, however, had to be abandoned at the beginning of 1948, owing to the difficulty of obtaining a vessel which could carry two Catalina aircraft, and the expense which the comprehensive programme of air survey would have involved. When Prof. H. U. Sverdrup was appointed director of Norsk Polarinstitutt in March 1948 he assumed responsibility, and under his direction a revised scheme was completed by May 1948.

Meanwhile, there had been considerable unofficial discussions in Norway, Sweden and the United Kingdom between those interested, and the Royal Geographical Society had advanced £2,000 from the Geographical Magazine Trust Fund to meet the initial expenses of a joint international expedition. A similar contribution, of Sw. Kr. 23,500, was made by Svenska Sällskapet för Anthropologi och Geografi (Swedish Geographical Society) in Stockholm. In June 1948 the Norwegian Storting approved the amended plans, and granted an initial sum of Kr. 200,000 (£10,000) for the preparations. In the following October the Norwegian Government extended a formal invitation to the Swedish and British Governments to participate in the expedition. It was proposed that three British and three Swedish scientific workers should take part, and that Norway, by reason of her territorial responsibilities in Dronning Maud Land, should provide the leadership and carry the main burden of the expense. This was estimated at a total of about Kr. 2,000,000 (£100,000); Sweden and the United Kingdom were each to contribute one-fifth, Kr. 400,000 (£20,000). In November 1948 the Swedish Government, and in December 1948 the British Government, accepted the Norwegian invitation. An international committee was set up. At an early stage it was agreed that financial liability should be vested in this committee and that Norsk Polarinstitutt should be the major guarantor, accepting any liability beyond the sums already promised by the United Kingdom, Sweden and the Norwegian Government. During the past year the preparations have been carried out by national committees in the three participating countries, with a central office at Norsk Polarinstitutt. The British committee, which includes representatives of Australia, New Zealand and South Africa, is known as the Joint Polar Committee, with the Royal Geographical Society and the Scott Polar Research Institute jointly responsible; there is also a small executive sub-committee. The work of organising the British participation has been centred in an office at the Royal Geographical Society.

During 1948 frequent meetings of the international committee took place. The members of the shore party were selected, and details of organisation were co-ordinated with the scientific programme.

The aim of this purely scientific expedition is to increase, primarily by geophysical methods, our knowledge of the ice, atmosphere and bare parts of the earth's crust, investigations which are of importance to a true understanding not only of local, but also of world-wide conditions. The most important object of the proposed work is to discover whether the recent climatic fluctuation, which has proved of such importance in the Arctic, is also taking place in the Antarctic. The programme is divided into three main parts: glaciology, for which Sweden is responsible; meteorology, for which Norway is responsible; and geology, for which the United Kingdom is responsible. In addition, Norway is responsible for topographical survey, which is basic to all the other investigations.

A special study is planned of the physical properties of the inland ice. For this purpose it is hoped to record temperatures at different depths down to about 100 metres during a period of at least eighteen months by electrical resistance thermometers. It is hoped to obtain a knowledge of the crystallographic structure of the ice by drilling out an undisturbed core to a depth of about 150 metres with a U.G. Straitline boring machine from the Canadian Longyear Co., and to make a careful examination of the structure of the upper parts of the frozen firn in open shafts. Seismic equipment has been provided with the view of sounding a profile of ice thickness along a north–south line between the coast and the mountains. More specific investigations at the base will include determination of the amounts and different kinds of accumulation (direct precipitation and snow drift), and ablation quantity (melting, evaporation and wind corrosion).

The meteorological programme at the base includes regular standard observations on the ground, upper air investigations with *radio-sonde* and *rawin* apparatus, measurements of radiation, and detailed observations of temperature up to a height of 8 metres. A special investigation is also planned of the amount of snow carried by high winds. Arrangements have been made for wireless transmission of daily weather reports. Co-ordination with the weather services of South Africa, Argentina, Chile, the British Meteorological Office (for the Falkland Islands Dependencies Survey stations), the French expedition to Terre Adélie, and with ships in the whaling fleet will make possible a synoptic weather analysis on the expedition's return. Financial provision for this analysis has already been made by Norway.

The leader of the shore party is Captain John Giæver, of Norsk Polarinstitutt, who has had considerable experience in the Arctic. Although responsibility for the scientific work has been divided among the three countries, the scientific observers will work together in groups irrespective of their nationality. The composition of the shore party is as follows: J. Giæver, leader (Norwegian); E. F. Roots, senior geologist (British); V. Schytt, senior glaciologist (Swedish); N. J. Schumacher, senior meteorologist (Norwegian); B. Ekström, mechanic (Norwegian); G. H. Liljeqvist, assistant meteorologist (Swedish); P. Mellebye, wireless operator, in charge of dogs (Norwegian); S. Nilsen, cook (Norwegian); A. Reece, assistant geologist (British); G. de Q. Robin, physicist and radar expert (British); N. Roer, surveyor (Norwegian); E. Rogstad, wireless operator (Norwegian); C. W. J. Swithinbank, assistant glaciologist (British); and O. Wilson, medical officer (Swedish). Messrs. Reece and Robin are former members of the Falkland Islands Dependencies Survey.

A small R.A.F. unit will accompany the expedition for the southern summer of 1949–50. The unit consists of: Squadron-Leader G. B. Walford (in command), Flight-Lieutenant H. M. H. Tudor, Sergeant P. D. Weston, Corporal W. B. Gilbey, and Corporal L. A. Quar.

Two specially fitted Auster aircraft will be used for ice reconnaissance, to search for a suitable site for the base on the shelf ice, and for inland reconnaissance flights to facilitate the planning of later sledging journeys. One of these light one-engined machines, which have a flight radius of 120 miles, will be assembled on deck if the ship is held up by pack ice during her approach to the Antarctic mainland. It has been crated so that only the wings and a few controls require assembly. Both machines have been fitted with skis and will operate from the ice; but, if necessary, one of them can be fitted with floats to operate from the sea.

Official observers from Australia and South Africa will join the expedition at Cape Town and will accompany the ship during its first summer cruise. The Australian observer is P. G. Law, a physicist from the University of Melbourne, who was senior scientific officer on board the *Wyatt Earp* during her 1947–48 Antarctic voyage, and who is now the officer-in-charge of the Australian National Antarctic Research Expedition. The South African observer is J. A. King, chief of the Synoptic and Forecasting Branches of the Union Weather Bureau.

The co-operation of government departments and private firms in all three countries has been generous, and the Expedition is probably better equipped than any previous one which has sailed to the Antarctic. Each country has provided of its best, and when an item has not been available in Norway, Sweden or the United Kingdom, it has been obtained from other countries. The clothing and sledging equipment, in particular, includes examples of designs and materials which can be tested against each other with the view of resolving differences of opinion that have long been the subject of discussion. It is also expected that comparative trials of different techniques of travel and living in polar conditions will go far towards establishing their relative merits.

Both dog and mechanical transport have been provided. The sixty dogs include thirty from the Falkland Islands Dependencies, presented by Sir Miles Clifford, and thirty from East Greenland and Spitsbergen. [Fifteen of these dogs have died *en route* (see p. 20).] In addition, the expedition is taking three 'Weasels'.

Trials of equipment were undertaken at Kebnekajse in Sweden, in March and August 1949, and on Hardangerjökel in Norway, in April 1949.

The Norwegian Hvalfangerforeningen (Association of Whaling Companies) undertook to transport the three 'Weasels' and the sixty dogs to the Antarctic in the whaling factory ship *Thorshøvdi*, which left Sandefjord on October 26, 1949. The bulk of the 200 tons of stores have been loaded on the *Norsel*, which will rendezvous with the *Thorshøvdi* in the Antarctic early in January 1950, when the 'Weasels' and dogs will be transhipped. The *Norsel*, under the command of Captain G. Jacobsen, is a Norwegian sealer of 700 tons, which was completed at Flensburg during 1949. She was at Göteborg during October 31–November 2, at Oslo during November 3–17, and at London during November 3–23, collecting the members of the Expedition with their stores and equipment.

The *Norsel* reached Cape Town on December 20. It is hoped that the base on the Antarctic mainland will be established somewhere between long. 5° E. and 10° W. during February 1950.

This is the first international expedition to the Antarctic, and the experience which it will provide is likely to have considerable influence on the future planning of such international projects.

SCIENTIFIC CENTENARIES IN 1950

By Eng.-Capt. EDGAR C. SMITH, O.B.E., R.N.

THE earliest names in the list of men of science whose centenaries fall in 1950 are those of John Napier, of Merchiston, Scotland, who was born in 1550, and René Descartes, the French philosopher, mathematician and physicist, who died in 1650. The former is universally known as the discoverer of logarithms, while the latter is remembered for his "Discours de la Méthode" and other works, his theory of vortices and his invention of analytical geometry.

Thirty-six years ago, in 1914, Edinburgh celebrated the tercentenary of the publication by Napier of his "Mirifici Logarithmorum Canonis Descriptio", resulting in the preparation of the "Napier Tercentenary Memorial Volume", edited by C. G. Knott. On the occasion of the commemoration, the inaugural address was given by Lord Moulton. "The invention of logarithms," he said, "came on the world as a bolt from the blue. No previous work had led up to it; nothing had foreshadowed it or heralded its arrival. It stood isolated, breaking in upon human thought abruptly, without borrowing from other workers or following known lines of thought." As a youth Napier, who is sometimes referred to as the Laird of Merchiston, sometimes as the eighth baron of Merchiston, studied at St. Andrews and then travelled on the Continent. He was interested in farming, politics and theology, and published a commentary on the Apocalypse. After his first marriage, in 1572, he lived mainly at Merchiston Castle. His first son, Archibald, was raised to the peerage by Charles I, and it was from him that came the long line of notable naval and military commanders bearing the name. Napier died on April 4, 1617, and was buried in St. Cuthbert's Churchyard, Edinburgh. Two years before his death he was visited by Henry Briggs, whose

life henceforth was devoted to the calculation of logarithmic tables, his "Arithmetica Logarithmica", published in 1634, containing the logarithms of 30,000 natural numbers to fourteen places of figures.

Like Napier, Descartes came of a noble family and was born on March 31, 1596, at La Haye Descartes, a small town in Touraine, now the department of Indre et Loire. Endowed with remarkable talents, as a boy he was taught by the Jesuits at the newly founded College at La Flèche, and as a youth in Paris he was friendly with Mydorge and Mersenne. For four years, 1617–21, he served first with Prince Maurice of Nassau and then with the Duke of Bavaria, and saw some of the fighting in the early part of the Thirty Years War. Then for seven years he worked and travelled in France, Switzerland and Italy, before settling in Holland, where he found himself free from irritating controversy. In 1649 he accepted an invitation from Queen Christina of Sweden to visit her at Stockholm. The colder climate unfortunately proved too much for him, and on February 11, 1650, when but fifty-three years of age, he died of inflammation of the lungs. His remains to-day lie in the church of St. Germain-des-Prés, Paris.

Cajori wrote, discussing the Cartesian theory of vortices: "After the overthrow of the Ptolemaic system and the rejection of the ancient crystalline spheres, the puzzle stared philosophers in the face, what is it that causes the planets to move in their orbits? The answers given in Descartes's theory were eagerly accepted. All space is filled with a fluid, or ether, the parts of which act on each other and cause circular motion. Thus the fluid was formed into a multitude of vortices of different size, velocity and density. There is an immense vortex around the sun, carrying in its whirl the earth and the other planets. . . ." For the best part of a century the theory held sway, and it was the faith on which Newton was brought up. In France it was not dispelled until the middle of the eighteenth century. Voltaire, in his chapter headed "On Descartes and Sir Isaac Newton", in his "Letters on England" (1733), wrote: "A Frenchman who arrives in London, will find philosophy, like everything else, very much changed there. He had left the world a plenum, and he now finds it a vacuum. At Paris the universe is seen composed of vortices of subtile matter; but nothing like it is seen in England. In France it is the pressure of the moon that causes the tides; but in England it is the sea that gravitates towards the moon. . . . You will observe farther, that the sun, which in France is said to have nothing to do in the affair, comes in here for very near a quarter of its assistance. According to your Cartesians, everything is performed by an impulsion, of which we have very little notion; and according to Sir Isaac Newton, it is by an attraction, the cause of which is as much unknown to us. At Paris you imagine the earth is shaped like a melon, or of an oblique figure; at London it has an oblate one. . . . This famous Newton, this destroyer of the Cartesian system, died in March anno 1727. His countrymen honoured him in his life-time, and interred him as though he had been a king who had made his people happy."

To-day, not less defunct than the Cartesian theory, is the geological theory of Wernerism, due to the great German mineralogist, Abraham Gottlob Werner, who, according to some authorities, was born in 1749, and to others in 1750. For forty years Werner lectured and dogmatized at the Freiburg Mining Academy, Saxony, raising it to the importance of a university, and imparting his own enthusiasm to his listeners. Two passages from Sir Archibald Geikie's "The Founders of Geology" may interest: "His influence and fame sprang from the personality of the man. His unwearied enthusiasm and eager zeal in the furtherance of his favourite studies, his kindness and helpfulness, his wide range of knowledge, and the vivacity, perspicuity and eloquence with which he communicated it, his unbounded confidence in the solidity of his theoretical doctrines—these were the sources of his power rather than the originality and importance of his own contribution to geology." As for what Werner did for the science of the rocks, Geikie wrote: "As the results of my own investigation in this subject, I have been compelled to arrive at the conclusion that, although he did great service by the precision of his lithological characters and by his insistence on the doctrine of geological succession, yet that as regards geological theory, whether directly by his own teaching, or indirectly by the labours of his pupils and followers, much of his influence was disastrous to the higher interests of geology". Werner's life was placid enough until the advent of the Napoleonic Wars, and the distress due to these had something to do with his death at Dresden on June 30, 1817.

There could be no greater contrast in the lives of two men of science than that between the careers of Werner and his contemporary, Déodat Dolomieu. The son of "François de Gratet, chevalier, marquis de Dolomieu, comte de Saint Paul d'Izeau, seigneur de Tuelin, Saint-Didier-les-Champagnes et autres lieux, et de haute et puissante dame Marie-Françoise de Bérenger", Dieudonné-Sylvain-Guy-Tancrède, Gratet de Dolomieu, was born on June 23, 1750, at Dolomieu, near La Tour-du-Pin, in Dauphiny. Early made a member of the Order of Malta, he served in ships of the Maltese Navy, killed a comrade in a duel and was sentenced to imprisonment for life, only to be released after nine months. He then served several years in the French Army. From early days, however, he was devoted to chemistry and other sciences. Able to mix in any society, he travelled extensively, climbed the Alps, the Pyrennees, and the extinct volcanoes of Auvergne, knew Italy, Sicily and Portugal, published many books and papers and took part in the French Revolution. He became one of the first members of the Institut de France and held a post in the School of Mines at Paris. As one of the group of scientific men who accompanied Napoleon to Egypt, he was a member of the short-lived Institut d'Egypt. While sailing for home, his ship took refuge in Taranto and he was made a prisoner. In his cell at Messina, with ink made from lampblack, he covered with notes the margins of a geological work of Faujas de Saint-Fond. Many were the efforts made for his release, and in one letter Sir Joseph Banks, then president of the Royal Society, wrote to Lady Hamilton at Naples asking her to solicit the assistance of "the gallant Admiral". After the Battle of Marengo, Napoleon made it a condition of the armistice that Dolomieu should be liberated. In 1801 he returned in triumph to Paris and began lecturing at the Museum of Natural History. Shortly afterwards, he visited his sister at Châteauneuf in Charollais, only to die there on November 26, 1801, when about to undertake a journey to Saxony to see Werner. So came to a close a life of activity, adventure and hardship, a fascinating account of which was given by M. Alfred Lacroix to the Paris Academy of Sciences on December 2, 1918. Dolo-

mieu's name is perpetuated by the useful magnesian limestone 'dolomite' and the range known as the Dolomites in the South Tyrol.

Passing from the men of science who laboured in the latter half of the eighteenth century to those whose work was done in the first half of the nineteenth century and who died a hundred years ago, the most important name is that of Joseph-Louis Gay-Lussac, one of the founders of modern chemistry. He was born on December 6, 1778, at St. Leonard in the department of Haute-Vienne, and from the days of his studentship at the Ecole Polytechnique his great abilities were recognized. He became especially celebrated for his numerous researches into the chemical and physical properties of gases and vapours. In 1804 he made two notable balloon ascents for scientific purposes, and in 1808 formulated Gay-Lussac's Law: When gases react together their volumes are simply related to one another and to the volumes of the products if these are gaseous. He lectured at the Ecole Polytechnique, the Sorbonne and the Jardin des Plantes, held government appointments, edited, with Arago, the *Annales de Chimie et de Physique*, in later years served as a deputy and in 1839 was raised to the peerage. He died in Paris on May 9, 1850. Forty years later, in August 1890, a statue of him was unveiled at Limoges. One of his contemporaries in England was Dr. William Prout (1785–1850), who, after taking his M.D. at Edinburgh in 1811, practised in London, lectured and experimented, and worked on the chemistry of the blood and the urine and of digestion. In 1815, in a memoir communicated to the Royal Society entitled "On the Relation between the Specific Gravity of Bodies in their Gaseous State to the Weight of their Atoms", he propounded the theory, known as "Prout's Hypothesis", that the atomic weights of all the elements are exact multiples of either the atomic weight of hydrogen or its half. His idea was widely discussed, being welcomed by some and rejected by others. It stimulated the exact determination of atomic weights, and later work has shown it to be remarkably near the truth.

Unlike any of the individuals already mentioned, William Sturgeon (1783–1850), the English electrician, started life with no advantages of birth or education. The son of a Lancashire shoemaker of no repute, and the apprentice of a worse, at nineteen he was a militia-man and at twenty-one a private in the Royal Artillery, and such he remained until his discharge on a pension of a shilling a day in 1820. But he was no ordinary private, for even in the barrack-rooms at Woolwich he gained a knowledge of mathematics, Latin and Greek, and at times amused the cadets of Woolwich Military Academy with his electrical experiments with kites. On his shilling a day he resumed boot-making, at the same time assisting to found a literary society and contributing to the *Philosophical Magazine*. Naturally, his zeal attracted attention, and in 1824 he was appointed a lecturer in science at the East India Company's Military Academy at Addiscombe, Surrey. In the following year he made history by presenting to the Society of Arts the first of all electromagnets with a soft iron core. It consisted of a horse-shoe of ½-inch bar iron about 12 inches long, wound with 18 turns of copper wire the ends of which dipped into cups of mercury. For this gift, since lost, the Society on May 21, 1825, awarded him the Silver Medal and thirty guineas. Just a century later, on May 20, 1925, Sir Ambrose Fleming read a paper to the same Society entitled "William Sturgeon and the Centenary of the Electromagnet", concluding with the remark that "Sturgeon's personal character, his high principles, blameless life, devotion to scientific truth and discovery, his genuine scientific achievements, as also his brave struggle against adverse fortune, brought him the respect and friendship of all good men". In 1840 Sturgeon returned to his native county, and he died at Prestwich, near Manchester, on December 4, 1850. For some years he had felt the pinch of poverty, only partially relieved by a small government grant.

The stories of the lives of such men as Dolomieu and Sturgeon stir the imagination and recall to mind the saying of Emerson, "I cannot even hear of personal vigour of any kind, great power of performance, without fresh resolution". Such is the effect of the story of Sidney Gilchrist Thomas, the young London police court clerk, who, working in his leisure, solved the important metallurgical problem of the dephosphorization of pig iron and so made possible the utilization of immense deposits of phosphoric iron ore hitherto considered useless. Born in London on April 16, 1850, he only lived to the age of thirty-four, and his early death, just when his discovery was being adopted all over the world, was partly due to the incessant demands on his mental and physical powers by the technical, financial and legal problems involved. The son of an Inland Revenue officer, he was educated at Dulwich School. His father's death in 1867 led to his abandoning all ideas of qualifying for a profession, and he obtained a clerkship in the Marlborough Street Police Court, from which he was transferred to the Thames Police Court, Stepney. After making himself competent in his duties, he took up the study of chemistry and physics, and it was a chance observation by a lecturer at Birkbeck College which turned his attention to the pig-iron problem. How he was assisted, first by his cousin, Percy Carlyle Gilchrist (1851–1935), F.R.S., then by Edward Pritchard Martin (1844–1910), Edward Windsor Richards (1831–1921) and John Edward Stead (1851–1923), F.R.S., will no doubt be told by Mr. James Mitchell at the commemoration of Thomas's centenary by the Iron and Steel Institute on April 26. Suffice it to say here that the success of the Thomas–Gilchrist process lay in the discovery of lining the melting furnaces with the mineral dolomite, and so the name of a pioneer in metallurgy is linked with that of a worker in the Heroic Age of geology. Thomas's death took place in Paris on February 1, 1885, and he was buried in the small cemetery at Passy. No country benefited more from Thomas's work than France, and on December 5, 1932, a special meeting of the Société des Ingénieurs Civils de France was held to commemorate the jubilee of the introduction of the Thomas–Gilchrist process. The meeting was attended by the President of the Republic, M. A. Lebrun, and addresses were given by Prof. A. Portevin, Dr. Léon Guillet and others. Many figures have been given showing the growth of the basic steel industry, and on this occasion it was stated that of 9,447,000 tons of steel produced in France in 1930, 98 per cent had been manufactured by the basic process, while 1,478,000 tons of phosphate slag had been marketed. Even when ill and living for a time in Algiers, Thomas had experimented with basic slag as an artificial fertilizer, thus placing agriculturists, as well as engineers, in his debt. In the history of discovery and invention, the story of Thomas is unique.

SELECTIVE TOXICITY*

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SELECTIVE toxicity may be defined as the science of injuring certain kinds of living cells without harming other kinds of cells in the vicinity. In practice, selective toxicity is used to injure uneconomic cells so as to favour survival of the economic cells with which they are associated. These uneconomic and economic cells may be related to one another as parasite and host, or they may be purely commensal.

Although a great deal of the research undertaken in this field has been empirical in character, there is an ever-increasing interest in attempts to develop the subject on a rational basis. Progress towards this end is important in facilitating teaching and in bringing a heightened sense of order to academic research. In addition, it has great potential value for the development of the applied side of the subject.

Some of the applications of selective toxicity have been strikingly successful. By the use of selectively toxic agents, the farmer has greatly increased his yield per acre because he has been able to suppress many fungi, weeds and insects which used to threaten his crops. It is a remarkable achievement to have discovered such selectively toxic agents as phenylmercuric nitrate for fungicidal seed-dressings, methylchlorophenoxy-acetic acid as a weed-killer and D.D.T. as an insecticide; these have materially aided agriculture by removing uneconomic forms of life, to the great benefit of the economic forms.

In animal husbandry, too, selectively toxic agents have greatly increased the productivity of man's economic animals by controlling many kinds of noxious parasites, both external and internal. Man himself, who is no less subject to infection than his economic animals, has also benefited directly. The special branch of selective toxicity that is concerned with the removal of parasitic organisms from man and his tended animals is known as 'chemotherapy'.

Selective toxicity has also been introduced into the much more complex situation where both economic and uneconomic cells form part of the same organism. This branch of the subject is known as 'pharmacology'. By pharmacological means it is often possible temporarily to suppress a natural function, such as the sensation of pain. An all-or-nothing effect will not serve, because a graduated response is required. This must be followed eventually by a complete reversal of the inhibition, because an anæsthetized patient does not expect to be deprived of feeling for the remainder of his life. Difficult as are the problems set by pharmacology, many selectively toxic agents have been discovered for use in this domain, some of them outstandingly effective.

Such achievements are remarkable and praiseworthy, but there are still many economic problems in selective toxicity awaiting solution. It is reasonable to believe that these problems will be more easily solved when (*a*) attention is closely focused on such connexions between constitution and activity as have been reliably established, and (*b*) when the search for underlying principles becomes intensified.

* Based on a series of eight public lectures given in the Biochemistry Department, University College, London, during the spring of 1949.

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Scientific Basis for Selective Toxicity

In some cases the basis of selective toxicity is simply a differential accumulation of the toxic substance. For example, a 20 per cent solution of sulphuric acid is still considered the best agent for removing chickweed from a wheat crop[1]. Although sulphuric acid is just as injurious to the cytoplasm of wheat as it is to that of chickweed, the weed is rough and the wheat-plant is smooth, so that the acid accumulates on the chickweed but is shed from the wheat.

However, in many cases, accumulation seems to play a comparatively minor part. For example, the powerful œstrogenic drug 'Fenocylin' is concentrated respectively 7 and 2·5 times more strongly in the intestines and liver than in the uterus, although it acts only on the last-named[2]. Many similar examples induce us to believe that a strong, localized biological action depends on a high degree of chemical specificity. This means a reaction that cannot take place to anything like the same extent in other than the affected cells.

This raises what seems, at first, a formidable difficulty: How can it be possible for toxic agents to act selectively on different types of cell when, as the major biochemical discoveries of the last decades have indicated, there is a common ground-plan for all living matter whether animal, vegetable or microbiological? For example, the Meyerhof sequence of glycolysis has been found in bacteria, Protozoa, worms, insects, echinoderms and vertebrates as well as in yeasts and the higher plants. There is no essential difference between the glycolysis of such a lowly form of life as yeast and some of the most highly organised tissues such as human muscle and liver. Moreover, it is well known that some vertebrate hormones can act on invertebrates and *vice versa*, and that the vitamins which are essential for man are also required by many bacteria (thiamine, riboflavine and nicotinic acid are apparently essential constituents of all living cells).

Remarkable as these similarities are, the very fact that one species behaves differently, and looks different, from another species is in itself a demonstration that marked biochemical dissimilarities exist. For the same reason there must be marked biochemical variations between different tissues of the one organism. For example, although the Meyerhof sequence of glycolysis is widely used in Nature, certain bacteria, yeast and fungi appear to be able to oxidize glucose directly and others oxidize glucose-6-phosphate directly. These methods, which are probably evolutionary relics, avoid the formation of pyruvic acid. Even where various species carry out identical biochemical tasks in glycolysis, identical enzymes are not always involved. For example, the alcohol-oxidase present in liver does not contain the active thiol groups present in the alcohol-oxidase of yeast[3].

The requirements for trace-metals also vary enormously from species to species. Take, for example, a need for molybdenum shown by nitrogen-fixing bacteria, for gallium in the case of the common mould *Aspergillus niger*[4] and the accumulation of vanadium by common protochordates. In short, a qualitative basis for selective toxicity plainly exists.

Even when similar metabolic pathways are used by two species, quantitative differences become apparent. Pathogenic trypanosomes, for example,

utilize glucose two thousand times faster than their hosts[8]. Their carbohydrate metabolism is more wasteful and more vulnerable than ours.

From these considerations it follows that *comparative biochemistry* is a branch of science which holds the key position for the logical discovery of selectively toxic agents. Unfortunately, little effort has been made to attract workers to this field, and little help can be expected from this quarter until more vigorous steps are taken. At present, comparative biochemistry tends more often to follow than to precede the discovery of a selectively toxic agent. For example, after the discovery of penicillin, it was found that this drug prevents the absorption of glutamic acid by those bacteria which it injures most. It was then found that these bacteria (for example, Staphylococci) are dependent upon an external source of glutamic acid, whereas human tissues and the types of bacteria which are least susceptible to penicillin are capable of synthesizing their own requirements of this acid[9].

Physical and Chemical Properties

From the point of view of present-day knowledge of the chemical bond, it is idle to classify selectively toxic agents into those that act by chemical means and those the action of which is physical. The term 'chemical reaction' is no longer restricted to the making and breaking of ionic and covalent bonds, because hydrogen bonds, ion-dipole bonds and multiple van der Waals bonds are known often to involve quite comparable amounts of energy. As Langmuir pointed out, even so simple an operation as the warming of water is actually a chemical depolymerization. Hence it is to be expected that the action of selectively toxic agents should often involve bonds which are neither covalent nor ionic.

The action of the greater number of selectively toxic agents depends on considerable specificity of structure. Such substances need to have particular molecular shapes with certain groups at particular distances. These conditions apparently enable combination with specific cell constituents to take place.

However, there is one class of agent which depends on certain physical properties making for accumulation. Such substances may be hydrocarbons, chlorinated hydrocarbons, alcohols, ethers, ketones, non-ionized bases (for example, aniline) or non-ionized acids (particularly phenols and barbiturates). These *structurally non-specific agents* are hypnotics for man (general anæsthetics if sufficiently volatile) and mild but effective poisons for insects. Their action apparently depends on their accumulating at some vitally important part of the affected cell where, for no other reason than that they are foreign bodies, the chain of respiratory processes becomes disorganised. Ferguson[7] has shown that all these substances have the same degree of biological action *when present at the same proportional saturation*. As an example of this principle, Ferguson cited the effect on the wireworm of various hydrocarbons and halogenated paraffins applied as vapours diluted with air. When equimolecular concentrations were compared, a 4,000-fold variation in activity was found. But when the substances were compared at the same proportional saturation (for example, by calculating the fraction of the saturated vapour pressure required to kill), a reasonably constant figure (0·5) was obtained. That is to say, these substances are equitoxic when air is half saturated with any one of them. Different constants are obtained for different kinds of biological result.

Structural Specificity

When, as is usually the case, toxic agents are structurally specific, it is not uncommon to find that the degree of specificity is indeed high. For example, only two (out of the possible five) monoaminoacridines are antibacterial, and only one of the three aminobenzenesulphonamides and one of the seven mono-hydroxyquinolines. Sometimes the presence or absence of an apparently chemically inert group makes all the difference between inactivity and a high degree of activity. Methyl groups are typical of those substituents which can profoundly increase biological activity without themselves forming new covalent linkages. There are four pathways through which this effect can operate. First, the insertion of a methyl group alters solubility; sometimes, surprisingly enough, the solubility in water is increased. Secondly, the oxidation-reduction potential is lowered through the inductive effect of the methyl group. Thirdly, similar inductive effects influence the ionization, thus weakening acids and strengthening bases. Fourthly, the molecule is changed in a steric sense and can make a better or worse fit on a vital biological surface (for example, an enzyme).

The importance of this fourth pathway is most clearly shown in the metabolite analogues, substances which are made chemically and sterically similar to some important cellular metabolite. If the resemblance is considerable, and yet not too great, the analogue usually has the effect of blocking the natural receptors for the metabolite, which then can no longer exert its proper biological action. Usually, the blocking action of the analogue can be reversed by an excess of the metabolite. Perhaps the most familiar example of a metabolite analogue is malonic acid, which competitively inhibits the enzyme succinic dehydrogenase because it displaces the normal substrate (succinic acid). Because succinic dehydrogenase is important in the metabolism of plants and the higher animals, malonic acid is of no use as a selectively toxic agent. However, Fildes and Woods showed in 1940[8,9] that sulphanilamide is antibacterial because it is a metabolite analogue of *p*-aminobenzoic acid, which is a substance of particular importance in bacterial metabolism. Woolley[10] lists forty metabolites (mainly vitamins and amino-acids) for which antagonistic analogues are known. In two cases, valuable drugs have been evolved directly from theoretical considerations of this kind.

One of these drugs is B.A.L. (British Anti-Lewisite), which is a selectively anti-toxic agent of great value in cases of chronic arsenical and metallic poisoning in man. The story of the rational steps which led to its discovery makes interesting reading[11]. The other drug is phenyl-pantothenone. When it was found that pantothenic acid greatly increased the survival time of malarial parasites *in vitro*[12] and hence was presumably an important natural metabolite, various analogous substances were tested as antimalarials. The best of these, phenyl-pantothenone, was found to be at least as effective as quinine in man[13]. Because of the commercial availability of 'Mepacrine', over which phenyl-pantothenone showed no special advantage, the new drug was not marketed. This does not in any way detract from the magnitude of the achievement.

Many other metabolite analogues are used in medicine and agriculture, although they were not discovered by planned experiments along the above lines. The possibilities of finding new selectively toxic agents by making analogues of known metabolites are considerable. Nevertheless, this procedure is not so simple as was at first thought, because special considerations of distribution arise.

Ionization

Among the various factors responsible for the action of selectively toxic agents, ionization phenomena must be accorded an important place. Many toxic substances are capable of ionization, and many of them are ionized to different degrees with small changes in *p*H. Conversely, at a given *p*H value, members of a series of substances, almost identical in chemical structure, usually are ionized to quite different degrees. These facts would be unimportant if both the ion and the neutral molecule of a given substance had the same biological action. But in all cases that have been investigated, they behave quite differently. These differences are quantitatively significant and often partake of an all-or-nothing character. In those cases where the ion is the more toxic, it might be thought that even a poorly ionized substance would produce a few ions and that as these are removed by the receptors of the cell fresh ions would be generated from the neutral molecules according to the mass action law. So far, all experimental evidence contradicts this assumption, any deficiency of ions in the solution being replaced not only from the neutral molecules but also from the complex which the ions form with the cellular receptors. These complexes are reversible, as is shown, for example, by crystal violet, which ceases to be bacteriostatic for *B. coli* at a dilution of 1 : 20,000, although the solution is intensely violet and still has many of the lethal cations present.

The acridine antibacterials present the most completely explored example of a positive correlation between ionization and biological activity[14]. In a series of a hundred and seven acridines of all kinds, those examples which were more than 50 per cent ionized at *p*H 7 proved to be highly antibacterial, whereas those which were poorly ionized showed little or no antibacterial action. It was shown, further, that the ionization must be cationic in type to be effective, anionic and zwitterionic examples being ineffective. It was further shown, by working in buffered media, that competition takes place between acridine cations and hydrogen ions, in a simple ratio, so that the acridine ions become increasingly more effective as the medium is made more alkaline (up to the point where alkalinity causes repression of ionization, as it can with the weaker bases). The simplest interpretation of these results is that acridine cations successfully compete with hydrogen ions for a vitally important anionic group (on the bacterium) and thus block it. It has been calculated from the data that such a group must have a pK_a of 9 or higher. Hence it could be a hydroxyl-group in the purine constituents of a nucleic acid.

More recently, it has been shown that in seven other families of heterocyclic bases, antibacterial action is proportional to ionization, and that this correlation can be extended to the smaller benzologues (pyridine and quinoline) so long as their molecules are substituted so as to provide the same area of flat surface as is provided by, say, acridine, phenanthridine or the benzquinolines[15].

On the other hand, the biological action of weak aliphatic and aromatic acids, of barbiturates and of bases having local anæsthetic action is more closely linked with the neutral molecule than with the ion. This effect was first noticed in 1921, when the antibacterial action of benzoic acid was investigated at various *p*H values[16]. It has since been shown that all members of a series of thirty barbiturates enter both eggs and larvæ of the sea-urchin exclusively as neutral molecules and that the resulting depression of cell-division and respiration, respectively, is also due exclusively to neutral molecules[17].

Binding of Trace Metals

Traces of various heavy metals have been shown to be essential for life. Some of the more bizarre examples have already been mentioned: more widely required metallic ions include copper, cobalt, zinc, manganese and iron. These substances are toxic in excess. Hence, it is evident that a selectively toxic action could be exerted by increasing the concentration of a metallic ion above the tolerance limit for the uneconomic cell, provided that this is below the tolerance limit for the economic cell. Conversely, a similar result could be obtained by reducing the concentration of a metallic ion below the minimum compatible with the life of the uneconomic cell, provided that the concentration in the economic cell did not fall below its minimal value.

So far, the exploration of these possibilities has scarcely begun, but the trace metal requirements of various cells is so different, quantitatively and qualitatively, as to encourage this approach to the discovery of new selectively toxic substances. These substances would have to be complexing agents, that is to say, they would have to be constructed so that they formed complexes with metallic ions, complexes so stable that they were in equilibria with only the minutest amounts of these ions (say 10^{-12} or less). It will not be forgotten that in Nature the metals are held by similar chelating agents such as the pteridines and amino-acids, so that the would-be toxic agent must compete with these for the metals. This competition is more likely to be successful if the new complex has a higher stability constant than the old in the equilibrium:

$$K = \frac{[\text{complex}]}{[\text{complexing agent}]^n[\text{metal ion}]}.$$

These constants can be readily determined by potentiometric titrations[18]. Researches of this kind will be greatly advanced when it becomes possible to design complexing agents that will be specific for particular metals under physiological conditions. (Unfortunately, the specificity of the analyst's spot-test reagents usually depends on boiling the solution or on the use of strong alkalis or acids.) The great majority of known complexing agents combine powerfully with copper and less powerfully (in this order) with cobalt, zinc, iron, manganese and magnesium. However, at least two substances are known which combine exclusively with iron, under physiological conditions, namely, α : α-dipyridyl and *o*-phenanthroline[19], and other examples of this type should be sought.

8-Hydroxyquinoline, which has been used clinically for fifty years as a powerful local antibacterial agent, has recently been shown to function by chelating one or more trace-metals in bacteria[20]. The six isomeric mono-hydroxyquinolines do not chelate and are not

antibacterial. On the other hand, various heterocyclic nuclei can be made just as effective against bacteria as 8-hydroxyquinoline is, by providing them with the same chelating mechanism, namely, a hydroxyl-group *peri* to the ring nitrogen. Thus 8-hydroxy-5 : 6-benzquinoline and 6-hydroxy-*m*-phenanthroline are equal to 8-hydroxyquinoline both in chelating power and in antibacterial activity. The chelating and the antibacterial properties both disappear if either the nitrogen or oxygen atom is methylated. Antibacterial activity fails to run parallel to chelating power only when groups are introduced into the molecule which prevent the metallic complex from being lipo-soluble. For example, 8-hydroxyquinoline-5-sulphonic acid and 4-hydroxypteridine are strong chelating agents, but their metallic complexes are water-soluble instead of being lipo-soluble. This factor seems to be of vital importance in the action of this class of compound, and it would seem that penetration of a cytoplasmic membrane plays an important part in their action.

The biologically important heavy metals with which 8-hydroxyquinoline chelates at *p*H 7 are : copper, cobalt, zinc, iron and manganese, and it is not yet clear with which of these its rapid bactericidal action is mostly connected. There is little doubt that, in the case of *Staphylococcus aureus*, iron (Fe^{++}) is the metal principally concerned[21]. In this case, the lethal action of the drug seems to be concerned with transporting iron (with which it combines relatively weakly) through the protoplasmic membrane, with the result that ferrous iron becomes present in toxic concentrations inside the cell.

The Covalent Bond

So far we have been able to discuss many important aspects of selective toxicity without more than a passing reference to the covalent bond. It is difficult for the organic chemist, who spends so much of his time making and breaking covalent bonds, to realize what a relatively unimportant part they seem to play in the action of selectively toxic agents. It is true that we know of a few drugs which do not exert their action until they are chemically altered by the body ; but the list is a short one. A typical drug of this class is the sulphonamido-azobenzene 'Prontosil', which functions in the body only after it has been reduced to sulphanilamide. However, it has been found preferable to administer sulphanilamide as such. Again, pentavalent arsenicals are known to act against spirochætes and trypanosomes only after reduction to the trivalent form ; but in the treatment of syphilis it has been found better to use trivalent arsenic directly. It is only when the organisms have penetrated into the central nervous system (whither trivalent arsenicals diffuse only slowly) that pentavalent arsenicals are found useful, because they penetrate well and then liberate trivalent arsenic where it is required.

Apart from such harnessing of the covalent bond to convey the drug to the site of action (or to retard its absorption), only rarely has it been shown to constitute the toxicity-determining linkage between the drug and vital cellular constituents. The reason may be that those toxic agents the affinity of which for cellular-receptors is tempered by a measure of reversibility are the more likely to show true selectivity, particularly where they are attacking chemical groups common to both the economic and the uneconomic cells. The reversibility of the action of selectively toxic agents when the experimental conditions are changed is a very well-known biological phenomenon. Such reversibility would not be expected, if covalent bonds are concerned, because of their high energy (40–100 k.cal. per gm. mol.) at 37° C., or lower.

Only in the case of arsenical drugs has the mode of action been traced to covalent-bond formation. Here the biologically effective reaction is believed to be :

$$R\text{—As}=\text{O}+2R'\text{—SH} \rightleftharpoons R\text{—As}(SR')_2+H_2O.$$

The As—S linkage has an abnormally low bond-energy and the reaction can be shown, *in vitro*, to go practically to completion in either direction at room temperature, depending on which substance is in excess. The formulation of the above mode of action of arsenical drugs (that is, combination with biologically important thiol-groups) was first suspected by Ehrlich[22] and placed on a reasonably secure basis by Voegtlin and his co-workers[23–26].

Some Landmarks in Chemotherapy

All branches of selective toxicity should benefit from consideration of the theoretical foundations of chemotherapy, which are better established than those of other sections of the subject.

Guided by his studies on the differential staining of living cells, Ehrlich decided, about 1899, to synthesize substances of low molecular weight which would attack (internal) parasites directly and leave the host unharmed. In 1904 he succeeded in curing trypanosomiasis in mice with Trypan Red (a synthetic chemical of low molecular weight), thus originating the first man-made chemotherapeutic agent. This conception that effective drugs would have relatively low molecular weights has been well substantiated, the majority of chemotherapeutic agents in current use having values between 170 and 600. This forms a contrast with the protective agents (antibodies) of immunotherapy (by sera and vaccines) which have molecular weights of at least 200,000.

Ehrlich's principal contention, that chemotherapeutic drugs act by a direct combination between their chemically active groups and other chemically active groups (called receptors) in the parasites, provoked much opposition. Many agreed with Uhlenhuth[27] that the drugs had no such direct action on the parasite, but worked by stimulating the natural resistance of the host. Others conceded that the drugs might act upon the parasite, but only after they had been chemically altered by the host[28].

The experimental evidence for testing these various hypotheses came nearly twenty years after Ehrlich's death in 1915. It was then shown[29] that normal trypanosomes, when treated with a solution of a trivalent arsenical, were rapidly killed, and the solution would not kill fresh trypanosomes. Hence it is possible to titrate the trypanosomes against the arsenical and thus calculate the number of chemo-receptor-groups which they contain. Clearly, susceptible strains of parasites possess groups with which they combine with the drug and so remove it from solution. On the other hand, when arsenic-resistant trypanosomes are treated with a trivalent arsenical, they are not killed and the residual solution will still kill susceptible trypanosomes.

About this time it was shown that the bodies of the killed parasites contain considerable amounts of

arsenic, whereas the resistant parasites contained none[29]. Advances in technique made it possible to demonstrate fixation of a drug by parasites while they were circulating in the host's blood stream. This was done, in turn, for 'Trypaflavin', antimony, gold and arsenic[31,32,33].

Ehrlich had always maintained that a drug needs two active groups, one to assist its uptake by the parasite and another to combine with a vitally active group in the parasite. Hence it follows that the mere uptake of a foreign substance need not be harmful to an organism. This was neatly demonstrated in 1935 when it was shown that malarial parasites and trypanosomes take up the three acridines, 'Atebrin', 'Trypaflavin' and 'Rivanol', but that the 'Atebrin' harms only the malarial parasites, the 'Trypaflavin' only the trypanosomes and the 'Rivanol' injured neither[34].

It is now generally agreed that the action of chemotherapeutic drugs is directly on the parasite, that their reaction with the parasite is chemical in nature and that there are two distinct reacting groups in many of the most active drugs. The co-operation of the natural defence factors of the body is also recognized. These factors, among them the reticulo-endothelial system[35,36], are believed to cope with the parasite once the drug has disorganised the latter's metabolism. The suggestion that some of Ehrlich's chemoreceptors are located in vitally important enzyme-systems[8] is one of the most stimulating suggestions made in recent years.

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OBITUARIES

Mr. John H. Reynolds

By the death of Mr. John H. Reynolds, British astronomy loses one of that long succession of amateurs who have contributed so much to the advance of the science they loved. In this case astronomical work in other countries has also been promoted by generous gifts. Early in this century, Mr. Reynolds secured a 30-in. Common mirror for his own use; but a visit to Egypt convinced him that more value could be obtained from his mirror if it were installed there than in his own garden. So an offer of a 30-in. reflecting telescope, with a mounting designed by Mr. Reynolds, was accepted for the Egyptian Government by Capt. H. G. Lyons, R.E. (later Sir Henry Lyons), of the Survey Department. A dome near Helwan was available, and the telescope began work on nebular photography in 1907. On the return of Halley's comet in 1910, the first photograph of it was secured at Helwan by Dr. Knox Shaw. Later, Mr. Reynolds installed a 28-in. reflector with the same type of mounting at his home in Harborne, where he began work in 1911. The 30-in. mirror was brought back from Helwan in 1923 to Birmingham. The second telescope was later presented to the Commonwealth Observatory on Mt. Stromlo, Canberra, where it is once more in full use in a photometric programme.

Mr. Reynolds's chief interest over many years was in nebular astronomy, particularly the extra-galactic nebulæ. He studied them in monochromatic light and in polarized light, examining their spiral forms, the distribution of condensations within them and their stellar development from type to type. He also examined them photometrically for internal light distribution. He obtained his material partly in Birmingham and partly at Helwan, for he maintained a close connexion with this Observatory from its start. He joined two eclipse expeditions, to Algiers and Egypt. He served for many years on the Council of the Royal Astronomical Society, mainly as treasurer; he was president during 1935–37. The University of Birmingham gave him the honorary degree of M.Sc. in recognition of his work for astronomy.

In addition to his normal business activities, Mr. Reynolds had other interests, being an accomplished musician. For some years he was honorary secretary of the Midland Institute, Birmingham, taking great interest in securing lecturers for it. He died on November 22, aged seventy-five, having collapsed at the close of a meeting where he had just taken part in the discussion of an astronomical lecture, showing that he maintained an active interest in astronomy right to the end of his life. F. J. M. Stratton

Mr. J. F. Marshall, C.B.E.

John Frederick Marshall, who died on December 5, at the age of seventy-five, was a leading authority on British mosquitoes. Son of the late Charles Marshall of Huntingdon, he was educated at Rugby and King's College, Cambridge, where he took a first class in the Mechanical Sciences Tripos, Part 1, in 1896, and in Part 2 (with special distinction) in 1898, and was called to the Bar, Inner Temple, in 1902.

Marshall first became actively interested in British mosquitoes about 1920 when, owing to their great prevalence in the neighbourhood of his home at

"Seacourt", Hayling Island, he organised a control scheme in 1921 after consultations with the late Dr. F. W. Edwards, of the British Museum (Natural History), and the late Colonel S. P. James, of the Ministry of Health. Marshall built, equipped and directed, at his own expense, the British Mosquito Control Institute in the grounds of his house on Hayling Island, which was officially opened by the late Sir Ronald Ross in 1925. This Institute is a centre for both pure and applied research upon mosquitoes, and has been visited by fellow-workers from all over the world.

Although some seventeen species of mosquitoes were recorded by Marshall as occurring on Hayling Island, the species which at times made life on the Island well-nigh unbearable was the brackish-water breeder *Aedes detritus* and, to a lesser extent, *Aedes caspius*. It was natural that Marshall should concentrate on a study of these two troublesome species, and his numerous publications show clearly with what meticulous care and accuracy he worked out their biology and bionomics. With his knowledge of mathematics he devoted much time, care and skill to insect photography, and invented a new apparatus for photographing insects, which he described in the *Bulletin of Entomological Research*. His greatest achievement, however, and the one which will for ever be associated with his name, is his book entitled "British Mosquitoes", which was published by the Trustees of the British Museum (Natural History) in 1938. It was the successor of Dr. W. D. Lang's "Handbook of British Mosquitoes" (1920). Marshall described nine species of mosquitoes not mentioned in Lang's book and also filled in numerous gaps in our knowledge concerning many species of which, although they were recorded as indigenous, very little was known. He added to our knowledge of their breeding-places, their bionomics and the means of classifying their larvæ, particularly the early instars. His book contains 172 text figures and twenty-five other drawings or photographs, most of which he did himself with the help of his enthusiastic assistant, Mr. J. Staley, and which bear testimony to the photographic apparatus which he invented. He was awarded the C.B.E. in 1936.

Between 1921 and 1925, I worked with Marshall while the mosquito survey of Hayling Island and the surrounding district was being made. The realization that the control measures necessary for success were both difficult and complicated stimulated Marshall and added an interest to this branch of the work which never flagged.

Marshall married in 1902 Blanche Gray, who survives him. She supported and helped him in all his scientific activities. Their daughter, Joan Grant (Mrs. Charles Beatty), is the talented author of "Winged Pharaoh" and other widely read literary works.

P. G. SHUTE

WE regret to announce the following deaths:

Dr. Clifford Dobell, F.R.S., protistologist to the Medical Research Council, on December 23, aged sixty-three.

Prof. W. H. Newton, professor of physiology in the University of Edinburgh, on December 20, aged forty-five.

NEWS and VIEWS

New Year Honours List

THE following names of men of science and others associated with scientific work appear in the New Year honours list:

Baron: Dr. L. Haden Guest, M.P., secretary of the Leverhulme Research Fellowship Committee, for political and public services.

K.B.E.: F. Brundrett, chief of the Royal Naval Scientific Service; H. C. Papworth, vice-chancellor of the University of Travancore.

D.B.E.: Prof. Olive Wheeler, professor of education and dean of the Faculty of Education in University College, Cardiff.

Knights: Prof. A. L. Bowley, during 1919–36 professor of statistics in the University of London; A. M. Bryan, chief inspector of mines, Ministry of Fuel and Power; Philip Hendy, director of the National Gallery; Dr. A. W. Pickard-Cambridge, deputy chairman of the Public Schools' Governing Bodies Association, during 1930–38 vice-chancellor of the University of Sheffield; S. J. Saint, director of agriculture, Barbados; Arthur Sims, for services to medicine and education in the British Commonwealth; Prof. A. G. Tansley, chairman of the Nature Conservancy; Dr. W. W. D. Thomson, professor of medicine, Queen's University, Belfast; Prof. R. L. Turner, director of the School of Oriental and African Studies, University of London.

C.B.: A. H. Gosling, director-general of the Forestry Commission; S. S. Hall, director-general of technical development (air), Ministry of Supply; Dr. O. H. Wansbrough-Jones, scientific adviser to the Army Council.

C.M.G.: A. B. Killick, director of agriculture, Uganda; W. H. Cocker, of Auckland, New Zealand, for outstanding services in university administration and adult education.

C.B.E.: J. Anderson, chief scientist, H.M. Underwater Detection Establishment, Portland; Mehmed Aziz, executive officer, Anopheles Eradication Scheme, Cyprus; O. G. S. Crawford, archæologist; H. W. Dawes, president of the Royal College of Veterinary Surgeons; A. N. Duckham, agricultural attaché at the British Embassy at Washington; Prof. F. Hardy, professor of chemistry and soil science, Imperial College of Tropical Agriculture, Trinidad; C. Harvey, director of agriculture, Fiji; Dr. Franklin Kidd, director of food investigation, Department of Scientific and Industrial Research; E. C. Lloyd, deputy chief veterinary officer, Ministry of Agriculture; Miss Ida C. Mann, senior surgeon, Royal London Ophthalmic (Moorfields) Hospital; Prof. J. W. Munro, professor of zoology and applied entomology in the Imperial College of Science and Technology, London; F. M. Owner, chief engineer (Engine Division), Bristol Aeroplane Co., Ltd.; Prof. F. G. Soper, professor of chemistry in the University of Otago, for public services; W. J. Spafford, lately director of agriculture, South Australia; K. T. Spencer, deputy director of aircraft research and development (technical), Ministry of Supply; Prof. A. M. Tyndall, chairman of the Executive Committee, National Physical Laboratory.

Military College of Science: Prof. A. Porter

Prof. Arthur Porter, professor of instrument technology in the Military College of Science, Shrivenham, has left to take up the post of director of research in the Canadian branch of Ferranti, Ltd. Prof. Porter is a graduate of the University of Manchester. During the period 1933–37 he worked under the direction of Prof. D. R. Hartree on the development and application of the Manchester differential analyser. This machine, which was the first of its kind to be built outside the United States, was applied to a wide variety of problems ranging from the determination of atomic wave functions by the method of self-consistent fields on one hand, to the study of non-linear electrical networks and terminated transmission lines on the other. After serving as assistant lecturer in physics during 1936–37, Dr. Porter obtained a Commonwealth Fund Fellowship and worked under Dr. Vannevar Bush at the Massachusetts Institute of Technology during 1937–39 on the development of the 30-integrator Rockefeller differential analyser. During the Second World War he worked in various government research establishments, including the Admiralty Research Laboratory, the Army Operations Research Group, and the Radar Research and Development Establishment, on anti-aircraft fire control and related problems. His main interest was the study of automatic and manual control systems and their application in military and industrial instruments and processes. He was secretary of the Ministry of Supply Servo Panel during its existence (1942–45), and he was also the secretary of the Interdepartmental Technical Committee on Servo Mechanisms from its inception in 1944. In May 1946 he joined the National Physical Laboratory and started a new section on automatic control problems, with particular reference to industrial applications. Porter joined the Military College of Science in October 1946, to be the first occupant of the new chair of instrument technology, and immediately threw himself into the very considerable task of organising courses in instrument technology and engineering physics and in establishing laboratories for these new subjects. While the courses and laboratories are not yet in a settled state, they do represent a very fine achievement for so short a time.

Mr. C. Holt Smith

Mr. C. Holt Smith has been appointed professor of instrument technology at the Military College of Science in succession to Prof. A. Porter. After completing his studies at the University of Manchester, where he took the degree of B.Sc., and serving an engineering apprenticeship, Mr. Holt Smith entered the Radio Department of the Royal Aircraft Establishment in 1926. His first work there was in connexion with microphones for use in aircraft, to which he made valuable contribution. At a later stage he turned his interest towards direction finding, and invented an automatic direction-finding system which was one of the earliest in the field. For a period he left government service and worked in the research department of the British Broadcasting Corporation, returning to government service in 1938. On his return he became responsible for the direction-finding and navigation work at the Royal Aircraft Establishment, in particular for the direction-finding equipment that was developed for Fighter Command. He then spent some two years at the Telecommunications Research Establishment on antenna research, afterwards serving for a little over a year as assistant director at Headquarters. He returned later to take charge of a flying unit which provided the flying facilities for the Establishment, including the special installation of radar equipment in aircraft. Eventually he became head of the Radio Department there, and as such has been responsible for research and development on airborne and ground radar systems, including radar types of navigational aids, not only for the Fighting Services but also for the Ministry of Civil Aviation.

Tribute to Prof. M. von Laue, For.Mem.R.S.

Prof. Max von Laue's seventieth birthday on October 9, 1949, was an occasion of celebration among German physicists and the world of science at large. Prof. A. Sommerfeld wrote in the *Physikalische Blaetter* that the best way of characterizing him is to call him the most outstanding and the most faithful of Planck's pupils. Laue received his doctor's degree from Planck in 1903, became Planck's assistant in 1905, and the two men always remained close friends. In 1909, Laue went as a lecturer to Munich where, as he puts it, "the atmosphere was saturated with the question whether X-rays were corpuscles or waves", a question which his own discovery soon settled. In 1912, he received the Nobel Prize for it. A tribute to Laue which Sir Lawrence Bragg sent to the *Physikalische Blaetter* includes the following: "I feel that of all living scientists I owe most to Professor Laue for making this discovery. I was just starting my career when it was announced; it decided the subject of my very first researches, and it has formed the basis of my scientific work ever since. This discovery opened up new vistas, a new science has been born as a result of it. . . . By his kindness, his courtesy, his courage, and his staunch adherence to his principles, he has gained international affection and esteem as well as international fame. . . ." Laue proved his courage and staunch adherence to principle during the Hitler regime, and he drew upon himself the wrath of Nazi men of science when he dared, in an obituary, to praise the great merits of Fritz Haber, who had died in exile. When Laue was in America in 1948, he wrote home: "On November 2, I received here in Chicago a honorary doctor's degree. The diploma describes me as 'a physicist and resolute champion of freedom', of which I am very proud. The International Union of Crystallography which, owing to its connexion with the United Nations, may not elect a German to its Board, has made me honorary president for life, and the American Physical Society an honorary member." Recently, Laue was elected a foreign member of the Royal Society (see *Nature*, May 21, p. 794).

Manufacture, Properties and Uses of Toughened Glass

A 16-mm. film on the manufacture, properties and uses of toughened glass was recently shown in London by Pilkington Brothers, Ltd., the manufacturers of 'Armourplate' and 'Armourlight' glasses. The film shows how, following the principle of 'Rupert's drop', glass plate can be toughened by heating to softening point and then rapidly cooling both sides with jets of cold air. The exterior surfaces contract on cooling, but the interior remains hot and plastic and yields

to the shrinking. However, when the interior afterwards cools, it undergoes great tensile stresses of contraction which can only be balanced by corresponding compression stresses on the non-yielding outside surfaces. Glass is strong in compression but weak in tension, and breaks when the critical tensile stress is developed on some part of its surface; with toughened glass this point can only be reached after first overcoming the surface compression, and as a result such glass has a breaking strength four to five times (or more, in some cases) that of glass in an ordinary annealed condition. Toughened glass is also very much more resistant to mechanical, and hence to thermal, shock; thus, it will withstand molten lead or, when hot, being sprayed with water. Because of the great strain energy stored within, toughened glass becomes reduced to small harmless granular particles on fracture, but suffers from the disadvantage that it cannot be cut, drilled, chipped, ground or otherwise worked (after toughening) without danger of such disintegration. It returns to the annealed condition at temperatures above 295° C. The film illustrates these properties by suitable demonstrations, and then goes on to indicate the wide range of uses in commerce and industry. It is produced by Cecil Musk and runs for twenty-one minutes. Copies are available on loan from Pilkington Brothers, Ltd., Publicity Department, St. Helens, Lancs.

Jenner Relics at the Wellcome Historical Medical Museum

THE bicentenary of the birth of Edward Jenner (1749–1823) was celebrated last May, and there is still on view at the Wellcome Historical Medical Museum a collection of books, manuscripts, and other relics relating to Jenner and to his discovery of vaccination. The catalogue (obtainable only from the Oxford University Press, 2*s.* net) is an interesting booklet, prepared by Dr. E. Ashworth Underwood, director of the Museum. A brief account of the life and work of Jenner is followed by a description of the contents of the Exhibition. The history of smallpox and of inoculation (or variolation) has been illustrated by a series of books, and portraits of their authors, from Rhazes in the eighth century to Daniel Sutton in the eighteenth. Personal relics of Jenner include the early works on natural history which gained for him the fellowship of the Royal Society, his publications relating to vaccination, his lancets, snuff-box, spectacles, pulsometers, cupping glasses, and the medals which were struck in his honour. Perhaps the principal exhibits, and certainly the most valuable, are two manuscript copies of the famous "Inquiry", written in 1797, and now for the first time placed on view together in the central show-case. The Wellcome manuscript, though not in Jenner's handwriting, is prefaced by a letter from him, while the other manuscript, lent by the Royal College of Surgeons, is written by Jenner himself and labelled by him as "the original paper". Other exhibits deal with the progress of vaccination, the spread of the practice at home and abroad, and the adoption of glycerated calf lymph as first suggested by Robert Koch. The catalogue is an important addition to Jenneriana, and it may well form, not only an essential guide to the Museum, but also a timely tribute to one of the central figures in medical history who, it must ever be remembered, was all his life a country practitioner in a remote Gloucestershire village.

Educational Films on World Resources

THE use of films for educational purposes grows, and a large number is now available. Therefore, a volume emanating from the United Nations is very welcome ("An International Index of Films on the Conservation and Utilization of Resources. Prepared by Unesco for UNSCCUR" (pp. 175; London: United Nations, 1949). The aim is to make available throughout the world material that might be useful in educational circles. There is a subject index, then an alphabetical index of titles, all in English, of some seven hundred films, and finally distribution sources and synopsis of each film. The length in minutes is given and colour or silence are noted, if necessary. There is, so far, no central library from which the films can be procured; but distribution sources are noted. While most films are available only in the language of their country of origin, some are available in English as well as a first language. Thus Danish and Dutch films can be obtained also in English, and most United Nations films in many languages.

Old Stone Age in the Sudan

A RECENT publication by A. J. Arkell, "Sudan Antiquities Service. Occasional Papers No. 1: The Old Stone Age in the Anglo-Egyptian Sudan" (pp. 52+27 plates; Khartoum: Commissioner for Archæology; Cambridge: Deighton, Bell and Co., Ltd., 1949; 25 P.T. or 5*s.*), is of very considerable interest to students of the Old Stone Age. It consists mainly of excellent illustrations of types of palæolithic tools found in the region. The text is kept to a minimum and explains the reproductions and their geographical occurrences. There is a distribution map and a table of a possible succession of cultures in the region, with discussions of geology and climatic changes. The whole is a small but valuable scientific work.

Colonial Students' Welfare in Great Britain

ON January 1 the British Council assumed responsibility for the welfare of Colonial students in the United Kingdom, taking over a task hitherto in the hands of the Colonial Office. The Council is taking over, and will retain for the time being, the Colonial Office hostels in London, Edinburgh and Newcastle, which together accommodate about 460 in shared rooms and dormitories; but its policy is to replace or adapt them so as to provide accommodation of a standard as near as possible to that of university halls of residence. As, however, only a small proportion of the 3,500 Colonial students in the United Kingdom can be housed in such residences, the Council will make every effort to obtain for the others suitable accommodation in boarding or private houses, and staff with this special responsibility have been appointed in London and at British Council centres outside London. It has been providing a range of services to a limited number of overseas students, and these will now be extended to all Colonial students and also to students from the self-governing countries of the Commonwealth and from foreign countries. Though the accommodation in the residences must for the time being be reserved for Colonial students only, it is planned to develop in them social and other activities in which British students will participate. In the London area the British Council is also extending the services it has been providing for its scholarship holders and bursars

and some other overseas students, so that they may be available for all the five thousand overseas students in the area.

Rajasthan Academy of Sciences, Pilani

THE Rajasthan Academy of Sciences was inaugurated in Pilani on November 27, 1949, by the Hon. Shri Siddharaj Daddha, Minister for Industries and Commerce, Rajasthan. The Hon. Shri Phoolchand Bafna, Minister for Local Self-Government, and the Hon. Shri Narsing Kachwaha, Minister for Labour, were also present on the occasion. The Academy has been started to encourage the progress of science, both pure and applied, in Rajasthan. It will publish, in due course, a *Journal* which will include papers on original research. At a meeting of the 'foundation fellows' of the Academy, Shri M. L. Schroff was unanimously elected president of the Academy for 1949–50, Dr. B. N. Mulay as vice-president, and Shri K. R. Ramachandran, of the Department of Botany, Birla College, Pilani, as secretary.

Congress of Animal Attendants

THE Laboratory Animals Bureau is holding a congress of animal attendants during March 30–31 at the Royal Veterinary College, Royal College Street, London, N.W.1. The morning of the first day will be devoted to a discussion on the formation of an Animal Technicians Association, and the morning of the second to the reading of technical papers. Both afternoons will offer a choice between a visit to a biological research laboratory, a programme of scientific films and a trade exhibition. The Congress is open to those, other than university graduates, whose work involves the use, care and handling of laboratory animals; it is not restricted to senior animal attendants. Admission will be by ticket, application for which should be addressed to the Director, Laboratory Animals Bureau, Royal Veterinary College, Royal College Street, London, N.W.1.

Conference on Semi-conducting Materials

A CONFERENCE on the properties of semi-conducting materials will take place at the University of Reading during July 10–15, 1950. The conference, which is assisted by the United Nations Educational, Scientific and Cultural Organisation, will be under the auspices of the International Union of Physics, in co-operation with the Royal Society, and will be organised by Prof. N. F. Mott and Prof. R. W. Ditchburn. Leading research workers from Czechoslovakia, France, the Netherlands, Sweden, Switzerland, the United States and Great Britain have accepted invitations to contribute papers. Their subjects include the conductive properties of non-metallic solids, photoconduction, barrier-layer rectifiers, crystal triodes, etc., and the relevant theoretical issues. The proceedings of the conference will be published in book form. A general prospectus can be obtained from the secretary, Dr. H. K. Henisch, Department of Physics, University, Reading.

University of London: Appointments

THE following appointments in the University of London have been announced: Dr. A. C. Dornhorst, to the University readership in medicine tenable at St. Thomas's Hospital Medical School from October 1, 1949; Dr. W. H. Hughes, to the University readership in bacteriology tenable at St. Mary's Hospital Medical School from October 1, 1949; Mr. Jack Joseph, to the University readership in anatomy tenable at Guy's Hospital Medical School from April 1, 1950.

The title of reader has been conferred on the following in respect of the posts they now hold: Dr. E. H. S. Burhop (mathematics, University College); Dr. Florence N. David (statistics, University College); Dr. C. A. Keele (pharmacology and therapeutics, Middlesex Hospital Medical School); Dr. L. Margaret Kerly (biochemistry, University College); Mr. Hyman Kestelman (mathematics, University College).

Norwegian–British–Swedish Antarctic Expedition

SINCE Dr. Brian Roberts's article on p. 8 was written, information has been received from the *Thorshovdi* that during the voyage fifteen dogs have died of an as yet unidentified disease. Of the forty-five remaining, which were also infected, thirty-nine have completely recovered. The loss of so many dogs is serious, but it appears that there is now little probability of further deaths from this cause. Huskies are highly susceptible to bacterial and virus infections. All of them had been inoculated against distemper, and eight out of thirty-one from the Falkland Islands Dependencies were lost as a result of an outbreak of hard pad disease before they left England. It seems possible that the latest infection originated with the remaining dogs which came from East Greenland and Spitsbergen.

Announcements

THE Adams Prize, offered by the University of Cambridge for an essay on a mathematical, astronomical or natural philosophical subject, has been awarded equally to Dr. J. C. Burkill, lecturer in mathematics in the University, Dr. S. Chandrasekhar, professor of theoretical astronomy in the University of Chicago (Yerkes Observatory), Mr. W. K. Hayman, lecturer in mathematics in University College, Exeter, and Prof. J. M. Whittaker, professor of pure mathematics in the University of Liverpool.

SIR JOHN LENNARD-JONES, Plummer professor of theoretical chemistry in the University of Cambridge, has been nominated a member of the honorary Advisory Scientific Committee of the National Gallery.

MR. A. W. MARSDEN, director of research, Angus Milling Co., Ltd., and associated companies in Scotland, has been appointed director of the Commonwealth Bureau of Dairy Science, the address of which is National Institute for Research in Dairying, Shinfield, Near Reading.

THE Medical Research Council is offering a research fellowship in psychiatry to be provided from a fund established by the late Dr. and Mrs. Edward Mapother. The Fellowship will be awarded to a suitably qualified graduate for whole-time work on the histochemistry of the nervous system, to be carried out under the direction of Prof. A. Meyer and Dr. H. McIlwain at the Institute of Psychiatry (University of London), Maudsley Hospital, Denmark Hill, London, S.E.5. The award will be made for one year, renewable annually for two further years. The stipend will be £600 per annum (with possible increase up to a maximum of £800) with an allowance for research expenses. Applications should be submitted, not later than January 31, to the Secretary, Medical Research Council, 38 Old Queen Street, Westminster, London, S.W.1.

VARIATIONS IN THE DISTRIBUTION OF RADIOACTIVE PHOSPHORUS PRODUCED BY ACTIVITY IN PERIPHERAL NERVES

By Dr. G. CAUSEY and Dr. G. WERNER*
Department of Anatomy, University College, London

USING colorimetric methods for the estimation of phosphorus, Gerard and Tupikova[1] report a proximo-distal gradient in the total phosphorus content of the sciatic nerve of frogs. In a previous review of nerve metabolism, Gerard[2] states that he could find no alteration of the longitudinal distribution of phosphorus on stimulation of the nerve. Roeder[3] reported indications of alteration in distribution of phosphorus in stimulated nerve, but regarded the results as inconclusive. During an investigation of the uptake of phosphorus-32 by rabbit nerves, we have found that gradients of distribution exist when the nerves are active.

The sural nerve and the nerve to the medial head of the gastrocnemius of adult rabbits were used. The sural nerve is distributed to the skin area on the lateral side of the ankle and contains sensory fibres. The gastrocnemius is a typical muscle nerve containing, of course, some afferent fibres.

Phosphorus-32 was injected intravenously in the form of a solution of disodium hydrogen phosphate, and later the sural nerve and the nerve to the gastrocnemius were dissected out in the thigh and upper part of the leg. The portions of nerve so obtained were divided into three approximately equal parts which are referred to as the proximal, middle and distal pieces. After weighing, the pieces were ashed and the solutions 'counted' in a fluid Geiger–Müller counting tube[4] under uniform conditions. All counts were corrected for background and decay and are expressed as counts/min. per 100 mgm. wet weight of nerve per 50 μc./kgm. dose.

Distribution of Phosphorus-32 in the Nerves of Anæsthetized and Unanæsthetized Rabbits

Six rabbits were anæsthetized with urethane or nembutal intravenously, and after 30 min. 1 ml. of radioactive disodium hydrogen phosphate was injected intravenously, representing 30–60 μc. of phosphorus-32 in different experiments; 20 min. later, the nerves were excised. In the proximal, middle and distal pieces of the sural nerve of each animal the counts were not significantly different (Table 1). In the nerve to the gastrocnemius there was a slight decrease distally, with a mean difference of 14 per cent between the proximal and distal counts.

Six rabbits were injected intravenously with 1 ml. of radioactive disodium hydrogen phosphate and allowed to move about the room for 20 min. They were then anæsthetized with urethane or nembutal or killed by a blow on the head, and dissected immediately. In the sural nerve there was found to be a marked fall in the counts distally as compared with proximally, the mean difference between the proximal and distal sections amounting to 37 per cent. In the nerve to the gastrocnemius there was a marked rise distally as compared with proximally, amounting in the mean to 50 per cent (Table 1). The corresponding pieces from the two sides were counted together, except in experiments Nos. 4 and 12.

Distribution of Phosphorus-32 in the Sural Nerve after Stimulation of the Sural Skin Area

These observations suggest that during activity of the nerve fibres, either phosphorus is carried along the nerve or the activity in some way causes a gradient in the rate of phosphorus-32 uptake along the nerve. This result was so arresting that it seemed necessary first to confirm that the gradients only occurred after nerve activity.

Eight rabbits were anæsthetized with urethane. Phosphorus-32 was injected intravenously as before; stimulation by pricking with a needle of the area of skin supplied by the sural nerve on the lateral and posterior aspects of the ankle[5] was begun at once and continued for 20 min. The stimulus was controlled, so far as possible, to produce a withdrawal reflex.

The counts obtained from the three sections of nerve on the unstimulated side did not differ significantly from each other, whereas on the stimulated side there was a marked diminution of the count distally compared with proximally, the differences being significant at less than the 5 per cent level (Table 2).

Table 1. Relative counts in the proximal (*P*), middle (*M*) and distal (*D*) pieces of the sural nerve and the nerve to the medial head of gastrocnemius after injection of phosphorus-32 in anæsthetized and unanæsthetized rabbits
The proximal count has been reduced to 100 in each case

Inactive				Active			
Exp. No.		Sural	Gastrocnemius	Exp. No.		Sural	Gastrocnemius
1	*P*	100	100	7	*P*	100	100
	M	97	98		*M*	86	179
	D	97	97		*D*	59	227
2	*P*	100	100	8	*P*	100	100
	M	98	100		*M*	90	141
	D	93	97		*D*	72	171
3	*P*	100	100	9	*P*	100	100
	M	108	84		*M*	85	141
	D	122	82		*D*	59	154
4*R*	*P*	100	100	10	*P*	100	100
	M	100	87		*M*	85	106
	D	96	67		*D*	63	103
4*L*	*P*	100	100	11	*P*	100	100
	M	97	87		*M*	54	105
	D	96	69		*D*	44	108
5	*P*	100	100	12*L*	*P*	100	100
	M	95	107		*M*	77	125
	D	91	122		*D*	74	139
6	*P*	100	100	12*R*	*P*	100	100
	M	102	97		*M*	87	116
	D	106	90		*D*	73	146
Mean	*P*	100	100	Mean	*P*	100	100
	M	100 ± 4	94 ± 7		*M*	81 ± 11	130 ± 24
	D	100 ± 10	86 ± 18		*D*	63 ± 10	150 ± 39

* World Health Organisation Fellow.

Table 2. Relative counts in the proximal (*P*), middle (*M*) and distal (*D*) pieces of the sural nerve of the unstimulated and stimulated sides of eight rabbits

The proximal count in each case is reduced to 100

Exp. No.		Unstimulated	Stimulated	Exp. No.		Unstimulated	Stimulated
13	*P*	100	100	17	*P*	100	100
	M	105	44		*M*	102	84
	D	106	27		*D*	108	67
14	*P*	100	100	18	*P*	100	100
	M	90	56		*M*	106	79
	D	80	45		*D*	112	73
15	*P*	100	100	19	*P*	100	100
	M	91	35		*M*	95	80
	D	80	18		*D*	92	65
16	*P*	100	100	20	*P*	100	100
	M	93	92		*M*	102	92
	D	85	81		*D*	97	68
				Mean	*P*	100	100
					M	98 ± 6	70 ± 21
					D	95 ± 12	56 ± 21

Distribution of Red Blood Corpuscles Tagged with Phosphorus-32 in the Sural Nerve and the Gastrocnemius

We next investigated the possibility that the gradient of phosphorus distribution depended on an altered distribution of blood resulting from stimulation.

The blood volume in the three sections of these nerves was investigated by the use of red blood cells tagged with phosphorus-32. 2 ml. of blood was incubated with radioactive phosphorus (20–40 μc.) for 2–3 hr. at 37° C. After centrifuging and washing, a suspension of the tagged red blood cells was re-injected; 5 min. later the nerves were removed and divided into three pieces, which were ashed and counted as described before. It has been shown that no appreciable amount of phosphorus-32 is lost from the red blood cells for 20–30 min., and therefore counts of the nerve pieces are proportional to their red blood cell content[4]. By this means it was shown that the red blood cell content of the proximal, middle and distal pieces of nerve were equal and were not altered in their proportion by either anæsthesia or stimulation. The variation of the content, expressed as counts/100 mgm. nerve, is random, and amounts between different levels of the same nerve or between opposite sides of the same animal to some 8 per cent.

It seems from these observations that the distribution of phosphorus-32, as shown by the counts, in peripheral nerves of rabbits, tends to be uniform in the resting, anæsthetized animal. But a distinct gradient is found when the animal is either moving spontaneously or the sensory end organs of the skin are stimulated mechanically in an anæsthetized animal. Further, it appears that in a nerve carrying fibres for cutaneous sensation the gradient is in the opposite direction to that found in a preponderantly motor nerve.

The uniformity of distribution of tagged red blood cells and the opposite direction of the gradients make it difficult to see any possibility of these phenomena being produced by local changes in blood supply.

Whether the gradients are produced by a local difference of the rate of uptake (or loss) of phosphorus-32 or by substantial transfer of a phosphorus compound with high specific activity should be demonstrable by an analysis of the specific activities of the different phosphorus fractions in the nerve. The whole subject is being further investigated and will be reported in full elsewhere.

We wish to thank Prof. J. Z. Young for his advice throughout this work, and the Royal Society for a grant towards the expenses.

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DYNAMICAL STABILITY OF ANTICYCLONES

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CYCLONES and anticyclones can be identified in weather maps from all parts of the globe, and are relatively restricted both in size and intensity (central pressure excess or defect). In 58 per cent of cases, the size of the subtropical anticyclonic cells lies in the relatively restricted range of 3,000–6,000 km.[1]. This is a fact striking enough to call for explanation, along with others, such as, for example, that the mean intensity of 'lows' in middle latitudes is of the order 20 mb., and not 200 mb. or 2 mb., whereas lows in tropical regions (excluding hurricanes) seldom exceed 4 mb. in intensity.

Little effort has been devoted to the elucidation of facts regarding the size and intensity of pressure-patterns. Rossby[2] has pointed out that the length of standing waves in the westerlies of middle latitudes is of the same order as the size of the large semi-permanent centres of action. More recently Priestley[3], on the basis of his control theory of pressure-variations, has shown that there is an upper limit, depending on the latitude, to the size of stationary systems, and that there is a lower limit to the closeness of approach of discrete patterns. This appears to be the extent of present knowledge of the factors determining the size of pressure-patterns.

It seems reasonable to assume that a discrete system attains a certain shape because that configuration gives the most stable disposition of the available total energy. Any closed dynamical system will tend to re-arrange itself until the total potential energy is a minimum. It would seem that this general principle holds the key to the determination of the size and intensity of pressure-patterns.

This basic principle of dynamic stability does not appear to have been applied previously to wind and pressure configurations on the meteorological scale. The reason may be that the meteorologist is reluctant to follow through to its ultimate conclusion the consequence of regarding pressure-patterns as discrete entities with an inherent structure. Yet as a forecaster, this is a hypothesis he accepts every time he attempts to extrapolate from to-day's to to-morrow's pressure-pattern.

The principle of potential energy minimization applies with particular directness to a plane, circular, gradient-wind anticyclone. It can be shown that the most stable possible organisation for such a system is a barotropic solid rotation with angular speed $\lambda/2$, $\lambda = 2\omega \sin \varphi$ being the Coriolis parameter in latitude φ. The radius R of the solid rotation is a

function of the given total energy, and the surface intensity is given by

$$h_0 = \tfrac{1}{4}\rho_0 \lambda^2 R^2,$$

ρ_0 being the surface density. The intensity is determined by R, and R is determined by the total energy, so that the equilibrium anticyclone is completely specified.

Atmospheric anticyclones do not have the structure of a solid barotropic rotation, except, perhaps, near the centre, the reason being that in the real atmosphere frictional forces cannot be ignored. The tendency is for friction to convert kinetic into potential energy, and hence to inhibit the realization of the true dynamical equilibrium of minimized potential energy. Equilibrium in an atmosphere with friction may be looked on as a minimization of potential energy subject to a constraint imposed by the frictional forces, the effect of the constraint being to alter the pressure-profile, and, with it, an associated dimensionless parameter, the *number*,

$$Q = 8\, h_0/\rho_0 \lambda^2 R^2,$$

which in the case of a solid rotation has the equilibrium value unity.

The number was estimated for twenty anticyclones appearing on surface weather maps for the Australian region during the last half of 1948. R was taken not as the 'size' but the 'spread' of the anticyclone, or the radius of maximum pressure gradient. (In the case of a solid rotation the size and the spread are identical.) Individual values are subject to large errors, due mainly to difficulty in evaluating the spread, and range from 1·1 to 3·8 with a mean of 1·9. Although observational error could account for the entire variation in Q, the possibility that the number may vary in different anticyclones cannot be excluded. However, such variation, if it exists, is of the order 2–3 to 1 or less, showing that there is a fairly narrow relation between the intensity and spread,

$$h_0 \approx \tfrac{1}{4}\, \rho_0 \lambda^2 R^2.$$

The intensity of an anticyclone tends to increase with its size, and with latitude, both facts of observation.

The spread of a 'high' depends weakly on the total energy, which may be shown to vary as $\lambda^2 R^4$. Hence 'highs' of quite different energy content in the same latitude will have comparable spreads. We have seen already that the size of subtropical 'highs' tends to bunch fairly closely about the mean value. The intensity of a 'high' of given spread depends on the latitude, an equilibrium 'high' in latitude 60° being three times as intense as one of the same spread in latitude 30°. This agrees with the observation that high-latitude anticyclones are in general more intense.

A cyclonic circulation is not limited to such small values of Q as an anticyclone. In a frictionless atmosphere, the equilibrium number for a cyclone is $Q = \infty$, that is, a cyclone of given intensity would tend to contract to a centrifugal vortex of infinitely small size.

There is, however, one consideration, apart from friction, which might tend to limit Q in a cyclone. It can be shown that if Q is greater than about 10, the vortex will exhibit hydrodynamic instability, that is, although the configuration as a whole may be dynamically stable, individual particles in some regions of the vortex will be unstable to lateral displacement. If we exclude such instability in a steady state vortex, we are limited to numbers of the order 10.

The mean number of seventeen intense cyclones studied by Goldie[4] works out at 9·4, suggesting that the necessity for hydrodynamical stability does, in fact, limit Q for extratropical cyclones. As the stability number for 'lows' is about five times the equilibrium number for anticyclones, 'lows' will in general be more intense, as is known to be the case. The nature of the variation of the intensity of 'lows' with spread and latitude is the same as for anticyclones.

The present investigation is part of the research programme of the Section of Meteorological Physics, Commonwealth Scientific and Industrial Research Organisation, and will be published in greater detail elsewhere.

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SYLVICULTURAL TREATMENT OF TROPICAL MIXED DECIDUOUS FOREST

IN a recent paper*, Mr. N. V. Brasnett discusses "Enrichment of Tropical Mixed Deciduous Forest by Planting".

The regeneration of tropical mixed forests of various types has been the subject of investigations for a very considerable period of years in India. Some of the later work of this century in connexion with tropical evergreen or true rain forests has been subjected to what may be termed new treatment, and this treatment had its beginnings in French West Africa, in the Ivory Coast and Cameroons and afterwards in the Belgian Congo and British Uganda Protectorate. The reasons underlying these attempts were mainly due to the fact that the forests in question had been exploited by timber companies which had extracted all the salable species up to and above the girth limit laid down by the Government. These marketable timbers were chiefly mahogany and one or two other species. The forests so exploited were then placed under the Forest Departments and, at the period being dealt with, were practically valueless from the big-timber market point of view, the local demand by the natives being very small.

As has been said, attempts have been made in India and also in Malaya, and, it may be added, in one or two other Colonies, to endeavour to obtain natural regeneration or introduce young plants of valuable species into the dense forests still standing, with the object of enriching them in the future. Success, however, was very doubtful. Leaving out of consideration here the question of Taungya working plantations, the first steps taken in French West Africa and in Nigeria were experimental gap planting. This consisted of planting or dibbling the seedlings of valuable species in natural openings where there was insufficient young advance growth. This plan after a few years trial was not considered practical, since it involved opening small inspection paths

* *Forestry Abstracts*, **10**, No. 4 (Oxford: Commonwealth Forestry Bureau, 1949).

connecting the gaps and demanded too exacting supervision from the staff. This gap method was introduced into the Ivory Coast in 1930; but by 1934 it was changed to what may be termed the line method of planting. Strips 10 m. apart were cleared through the forests parallel to one another and planted with nursery transplants 2½ m. apart, the transplants being of valuable species such as mahogany (*Khaya ivorensis*), and in the case of the Ivory Coast *Lovoa klaineana, Tarrietia utilis, Terminalia ivorensis, Entandrophragma utile* and *E. angolense*. This was revised, and the standard practice at present is opening lines 20 m. apart and planting the plants in the lines at 5 m. intervals. This gives an initial stocking of 100 plants per hectare. The work necessitates a considerable labour staff, since weeding and cleaning and climber cutting must be carried out in the first few years—from four to six years—and overhead side-covering must be removed by girdling neighbouring trees. It appears to be generally held in French West Africa that this line planting, although expensive, is simpler to carry out with the available native staff who have not got any real forestry training than to endeavour to establish advance growth and natural regeneration over considerable areas which requires very careful supervision and larger additions to trained staff.

At first, small nursery transplants were made use of in this planting work. A very considerable mortality ensued from weeds, although these were kept under by the staff employed, from small antelope, which browsed on the plants in the lines thus cleared, and from insects. In 1934 the present writer was shown, in the Ivory Coast, a method which was just starting to be employed. The nursery plants were grown 1½–2 m. high instead of being the smaller stock, and they were stripped of their side-branches except for 2–4 leaves left at the top of the plant. This had the effect of placing the leading shoot out of the reach of browsing deer. They were also less liable to suppression from weeds and less subject to attack by insects. This method was afterwards made use of in the Budongo Forest of Uganda, where considerable development in this matter has been made, as also in the Belgian Congo. It is impossible to go into all the details here; but the main point about this work is the recognition that natural regeneration of the required species is deficient in these exploited forests and cannot be induced in adequate quantity and distribution by any known sylvicultural methods without, perhaps, the employment of an amount of skilled supervision which would prove entirely unremunerative. In the tropical rain forest or evergreen forest, containing a large number of species of trees in mixture, the lower stages of the forest and the forest floor are usually covered with dense evergreen or semi-evergreen woody shrubs and so forth, through which seedlings of the more valuable species that demand a certain amount of light cannot penetrate; and therefore the younger age classes of the valuable species are very scarce or altogether absent. The French and Belgians have standardized 100 plants per hectare, both hoping to obtain 20–50 per hectare in the final crop. In Uganda only about 58 per hectare, in the ultimate hope of obtaining 16–20 per hectare, are planted.

There are no examples of enriched areas more than nineteen years old, and only those up to thirteen years old were made with large plants, that is, 1½–2 m. in size. These are examples of what may be expected from the modern technique. Forecasts of the yield are attempted, but this cannot be very much more than guess-work. Labour costs are estimated at about 75–80 man-days per hectare for all operations up to the final thinning.

It is a pity that this valuable paper was not read before the recent World Forestry Congress at Helsinki which took place the month following the publication. This question of the enrichment of tropical forests was ventilated in more than one section at the Congress, and views were expressed, based obviously on the want of practical experience of the sylviculture of these types of forest and the treatment which it demands, even though a full appreciation of this treatment has not yet been fully realized. Mr. Brasnett with his paper would have been of very real help in the discussions which took place on this subject.

E. P. STEBBING

INDIAN RESEARCH FUND ASSOCIATION

ANNUAL REPORT OF THE SCIENTIFIC ADVISORY BOARD

THE report of the Scientific Advisory Board of the Indian Research Fund Association for the year 1948* includes a comprehensive account of the researches carried out during the year together with the reports of the Advisory Committees for Cholera, Malaria, Nutrition, Leprosy, Plague, Clinical Research, Maternity and Child Welfare, Filariasis, Industrial Health and Pharmacology. The bulk of the work carried out under the Board is, as the titles of these Committees indicate, medical or biological, and a list of papers on medical research published under the auspices of the Association during the year is appended, lists of papers on malaria, nutrition, leprosy and clinical research being also provided with the report of the appropriate Advisory Committee. In the field of malaria, the insecticide and mosquito-repellent inquiry under the direction of the Malaria Institute of India, Delhi, reports some progress with suspensions and emulsions of D.D.T., and 'Gammexane'; Dr. D. N. Roy has continued his study of the control of sandflies, *P. argentipes*, by spraying with D.D.T., and Dr. K. Ganapathi, at the Haffkine Institute, Bombay, his syntheses of thiazoles with a *p*-chlorophenyl-amino group in the thiazole ring and of 4-substituted quinolines for examination as anti-malarials.

Nutrition researches under Dr. V. N. Patwardhan at the Nutrition Research Laboratories, Coonoor, have included studies on the vitamins of the B-complex, on the mode of action of vitamin D and the conversion of carotene into vitamin A in the intestine of the albino rat, on the human metabolism of hydrogenated groundnut oil and experimental lathyrism. At the Grant Medical College, Bombay, Mr. N. C. Datta has studied the formation, function and variations of plasma-proteins in health and disease, while the Nutrition Research Unit under Dr. R. G. Chitre at the Seth G.S. Medical College, Bombay, has investigated the absorption of fats from intestines, the comparative nutritive values of vanaspati vegetable-oil and butter, the nutritive value of milk

* Report of the Scientific Advisory Board for the Year 1948. Pp. xii+245. (New Delhi: Indian Research Fund Association, 1949.) 1 rupee.

and curds and of pure-bred strains of cereals and pulses, and the estimation of the so-called "precursor of nicotinic acid" from vegetable foodstuffs and vitamin D. The Nutrition Research Unit under Dr. B. C. Guha at the University College of Science and Technology, Calcutta, has worked on the biosynthesis of ascorbic acid, the biosynthesis of fat with special reference to the role of thiamin and riboflavin, and the biological availability of iron in wheat and other foods. Under Prof. M. Damodaran at the Laboratories of the Council of Scientific and Industrial Research, Delhi, the relation of dietary protein to blood and muscle hæmoglobin, the biological importance of plant carotenoids and the growth-promoting factor present in Bengal grain have been studied.

Under Dr. Dharmendra at the School of Tropical Medicine, Calcutta, the therapeutic value of derivatives of diaminodiphenyl sulphone in leprosy has been investigated, while under the director of the Haffkine Institute field trials have been conducted with streptomycin, sulphadiazine and sulphamerazine in the treatment of bubonic plague. Research on the experimental production of cancer of the liver in rats by feeding with *p*-dimethylaminoazobenzene has been completed by the clinical research unit at the Tata Memorial Hospital, Bombay, under Dr. V. R. Khandkar, and at the Haffkine Institute the role of nutritional factors in hepatic cirrhosis has been studied by Dr. M. V. Radhakrishna Rao. At the School of Tropical Medicine, Calcutta, Dr. S. Banerji has investigated the effect of vitamin C and vitamin B_1 in diabetes and of vitamin C in hyperthyroidism; Dr. A. K. Mukerji the life-history of *Gastrodiscoides hominis* with a view to preventive measures; Dr. R. N. Chaudhuri the variation of plasma-protein levels and glucose-absorption and glucose-tolerance in the enteric group of fevers; and Dr. J. C. Ray the significance of endogenous allergens in the etiology, diagnosis and treatment of allergic diseases. Appended to the report of the Clinical Research Advisory Committee are a note on the establishment of hæmatological units for standardizing liver extracts manufactured in India and also the rules and regulations for the conduct of clinical trials of new remedies under the Indian Research Fund Association.

Two inquiries into anæmias of pregnancy have been conducted for the Maternity and Child Welfare Advisory Committee; but the greater part of the report of that Committee describes Dr. C. C. Sekar and Dr. Muktha Sen's investigation of the reproductive patterns of an urban area in central Calcutta and a rural area in the Hooghly district. Screening tests against Microfilariæ *in vitro* at the School of Tropical Medicine, Calcutta, are reported by Dr. A. K. Mukerji, while Dr. B. B. Dikshit of the B.J. Medical College, Poona, and Dr. K. Venkataraman, director of the Technology Department, University of Bombay, have investigated the preparation of surface-active antimonials for the treatment of filariasis, as well as the synthesis of 4-hydroxystibanilic acid and derivatives of 4-aminosalicylic acid and the influence of wetting-agents on the antifilarial activity of cyanine dyes. In the field of industrial health, attention has been given to the effects of excessive noise on efficiency, the incidence of lead poisoning in printing presses, sickness absenteeism due to accidents at the Bata Shoe Factory, fatigue and efficiency in paper and textile industries, and the effect of environmental conditions such as lighting, temperature, humidity, ventilation and dust in certain industries in and around Calcutta.

In the field of pharmacology, investigations into indigenous drugs have covered plants yielding essential oils, the male ferns of Kashmir, Indian wild cherry bark, *Dæmia extensa* Linn., the determination of the alkaloids of *Rauwolfia serpentina* in body fluid, the alkaloids of *Cissampelos pareira* Linn. and *Zizyphus jujuba* Lam.

CHEMISTRY AT KING'S COLLEGE, NEWCASTLE UPON TYNE

THE new Chemistry Department of King's College, Newcastle upon Tyne, of which the Inorganic and Organic Sections are now completed, was opened on December 10 by Sir Robert Robinson, president of the Royal Society. Viscount Ridley, chairman of the College Council, presided, and was accompanied by the Lord Mayor of Newcastle upon Tyne and the Rector of King's College. The big assembly included representatives of various chemical organisations and of industry in Great Britain, together with many past and present members of staff of the Chemistry Department and of the College as a whole, and a large number of old chemistry students.

Sir Robert Robinson submitted the general thesis that there is still a vast amount to discover about chemistry and that, although he spoke as an organic chemist, he did not doubt that representatives of other branches of chemistry would say the same for their sections. As examples he instanced penicillin and cortisone, and illustrated the point by demonstrating the surprising interaction between urea and *n*-dodecane.

Although the constitutions of both penicillin and cortisone are known and their syntheses have been effected in the laboratory, we have not enough knowledge of chemistry to be able to synthesize them economically on the scale in which they could be used with advantage. Thus the laboratory synthesis of cortisone involves thirty-five stages, and starting with 1,000 kgm. of raw material and assuming a yield of 50 per cent at each stage, only one-twentieth of a milligram of cortisone would be obtained at the end. We must accordingly have much more knowledge of chemistry, and for that reason up to-date and well-equipped laboratories are very necessary. Sir Robert said that a great debt is owed to the authorities of King's College for their achievement in erecting and equipping so magnificent a building in a time of difficulties and shortages.

Organic chemistry occupies a central position in the science between the inorganic and physical branches which merge into theoretical physics, and biochemistry which merges into physiology and medicine. Prof. G. R. Clemo, director of the Department of Chemistry, is an organic chemist and therefore is well qualified to steer his Department "between the Scylla of partiality and Charybdis of impartiality".

In proposing the vote of thanks to Sir Robert, Prof. Clemo compared him to a Wren, a Faraday and a Pasteur in one: a Wren because no chemist approaches him for insight into the structure of Nature's molecular masterpieces; a Faraday because, with Lapworth, he was a pioneer in the application of electrochemical ideas to the explanation of organic chemical reactions; a Pasteur because his unrivalled skill and knowledge have led

New chemistry building, King's College, Newcastle upon Tyne

to, among many other like achievements, the synthesis of stilbœstrol and the elucidation of the structure of penicillin. It is to be hoped that he will add many further such chapters to the glory of chemistry and the good of mankind.

The new Chemistry Department was then opened for inspection. During the evening a reunion dinner was held when many old chemistry graduates of the College attended, headed by Dr. Smythe, who graduated in 1895, and Dr. Watt, who graduated in 1900.

The completed portion of the new Department is L-shaped, and one wing of the basement contains the main stores, connected by a central service lift with subsidiary stores on each floor. In the other wing is the main lecture theatre, seating 275, which occupies both the basement and ground floor. The approaches at basement-level are to the lecture bench from two preparation rooms. The basement in this wing also contains small rooms for electrical equipment, a large centrifuge, a constant-temperature room, and an ice-making plant. The curtains of the theatre can be drawn and the lighting dimmed from the lecture bench, which also has panels for providing A.C. and D.C. electric current at various voltages. Noxious fumes can be removed directly from the bench.

The theatre is approached on the ground floor through foyers at either side. On the left of the entrance hall is a second lecture theatre, seating 145, with lecture bench equipped as for the main lecture theatre; and opening from the far end of this hall is the new Johnston Laboratory, accommodating 144, and used for the teaching of elementary inorganic chemistry. Leading out from the main Laboratory are two balance rooms and laboratories for individual lecturers and the office of the laboratory steward. The private rooms and laboratories for members of staff responsible for the teaching in each of the big laboratories are situated adjacent to the laboratories in question.

On the first floor above this Laboratory are the private room of the reader in inorganic chemistry, two large research laboratories and a teaching laboratory, accommodating 80 honours students, for advanced teaching in inorganic chemistry. Leading from this is a balance room, a constant-temperature micro-balance room, a large special-purposes room containing a Spekker, polarograph, Sands's apparatus, etc., a dark room, and the private laboratory of a lecturer. The research rooms are arranged so that, besides the usual benches and fume-cupboards at the sides, there is a great deal of free floor space with services available from points at or near floor-level, so that large pieces of apparatus can be erected on movable tables or low benches as may be required. An X-ray set with cameras for powder and single-crystal work is available.

On the main landing is the Departmental Library, and in the other wing there is a laboratory at present used for supplementing the teaching of physical chemistry, with a balance room, a dark room and a private laboratory for a lecturer.

The second floor contains the elementary organic laboratory for some 128 students, a balance room and private rooms and laboratories for two lecturers. The Dunn Laboratories, devoted to analytical work in organic chemistry, are also situated here, and consist of a specially fitted laboratory for micro-analysis with its thermostatically controlled balance room, with the balances mounted on special anti-vibration benches, and dark rooms for absorption spectroscopy, polarimetry, etc. In the other wing are a private

room and laboratory for a lecturer, and the Advanced Organic Laboratory used by second- and third-year honours students.

The third floor contains the private rooms and laboratory of the professor of organic chemistry, common rooms for staff and research students, and a third lecture theatre to seat 50, with a preparation room and museum. A large and completely equipped laboratory provides accommodation for thirty research workers in organic chemistry, and there are, in addition, a private room and laboratory for one or two members of staff, and a special-purposes laboratory in which are hydrogenation apparatus for operation on various scales from quantitative micro-work to fairly large-scale pressure autoclaves, shakers, a multiple molecular still, refrigerators, apparatus for the quantitative determination of deuterium, filter presses, a large vacuum evaporator, vacuum oven, ozonizer, etc. On the roof there is a laboratory with windows on three sides arranged for experimental work with noxious fumes and equipped with a concrete bench for all-night operations involving gas heating and the use of water. Adjoining is the air-conditioning plant which pumps filtered and warmed air into every room. The temperature of the incoming air, and thus largely that of the building, is controlled by thermostats at key points, and foul air automatically finds its way out of the building aided by fume-cupboard fans through acid-proof ducts. In the laboratories the air is changed six times an hour, and in the lecture theatres twelve times. The fume cupboards in the organic laboratories are situated in the windows.

The benches have been designed so as to render all the services easily accessible, and in case of necessity any service on any bench can be cut off in a few moments without interfering with that service to the remaining benches in the laboratory. The services available to the benches are suited to the type of work carried out on them, and include in the majority of cases electric current at mains and low voltages, hot and cold water, gas and steam. Where requisite, vacuum and compressed air are also provided.

INSTITUTION OF GAS ENGINEERS

AUTUMN RESEARCH MEETING

THE fifteenth Autumn Research Meeting of the Institution of Gas Engineers was held in London, under the presidency of Mr. C. H. Chester, during November 29–30—the first since the gas industry passed into the control of the National Gas Board. The technical matters discussed revealed the continued search for sources of raw material available for making gas or new techniques for carbonization or gasification of solid fuels.

Of great interest was an account of new experience on the process of gas purification with oxide of iron. In Great Britain statutory requirements for the removal of hydrogen sulphide from town's gas are extremely exacting. The method consists in passing the unpurified gas over suitable oxide of iron contained in large boxes, and the process, though effective, has certain disabilities which cause a perpetual if unsuccessful search for substitutes. These disabilities are due to the size and cost of the plant, coupled with the amount and cost of the labour used in operation. In the past, the latter has been due largely to the caking of oxide of iron after 'fouling', and this has been ascribed to accumulation of tarry matter and of salts insoluble in water, in addition to the sulphur deposited. F. J. Dent and L. A. Moignard have put forward a new explanation, although a hint of this was given by H. B. Avery in 1939 when he observed the disintegration and migration of iron in the mass of used oxide. Arising from this, Dent and Moignard have developed an explanation of the caking and hardening of the oxide. In the purification process, the foul gas leaves a film of iron sulphide on the surface of the oxide which, assisted by the moist condition, leads to a migration of iron sulphide and its deposition at points of contact of the material comprising the charge of oxide. This deposit provides the cement for the construction of the hard cakes actually found and causing the above-mentioned difficulties; laboratory tests show that caking can be obtained in the absence of tarry and other deposits. This work has provided, for the first time, a plausible mechanism for the purification of coal gas by means of oxide of iron, and it should be possible, by its application, to secure advances in the efficiency and economy of purification processes.

Removal of tar is, however, necessary in order to recover clean sulphur, which is promoted by the almost complete removal of tar-fog from the gas by electrostatic precipitation. In a paper by K. W. Francombe, it is shown how this technique is growing and will soon be universal practice. R. H. Williamson and J. E. Garside described another way for operating a process of purification without the trouble of caking, that is, to use the new technique of 'fluidization'. The oxide of iron in finely divided condition is carried in a state of suspension by the gas to be purified; in this way the whole process of 'fouling' and 'revivification' is completed without the formation of caked aggregation. On a laboratory scale a measure of success has been obtained.

In the past, town's gas has been obtained by the carbonization of coal, leaving a residue of coke, or by the gasification of solid fuel which has necessitated the use of mineral oil. In recent years, attempts have been made to replace these oils by gaseous hydrocarbons obtained by synthetic processes. F. J. Dent and D. Hebden have described synthetic processes on two lines: (*a*) at atmospheric pressure from a type of 'blue water gas', and (*b*) at a pressure of 20 atmospheres with a hydrogen-rich gas such as could be obtained by pressure gasification of coke or breeze. The results hitherto obtained show such promise that the Gas Research Board is taking steps to continue this work on a larger scale. The synthesis of hydrocarbons from coal to replace those obtained from imported oils and from high-grade bituminous coal would be of considerable national importance.

The manufacture of fuels by carbonization or gasification of coal usually creates trouble by formation of noxious liquid effluents, especially in Great Britain where population is dense and rivers are small. The trouble arises because of poisonous materials such as cyanides, tar acids and bases, and sulphur compounds which remove dissolved oxygen necessary for fish and other life. The new Gas Act of 1948 has placed the responsibility for avoiding the pollution of rivers on the area gas boards. This difficult problem has long been a source of concern to the gas industry and an increasing subject of research. E. H. M. Badger gave an account of the problem of effluent liquor disposal in all aspects. A plea was made for more collaboration by all parties.

H. J. HODSMAN.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

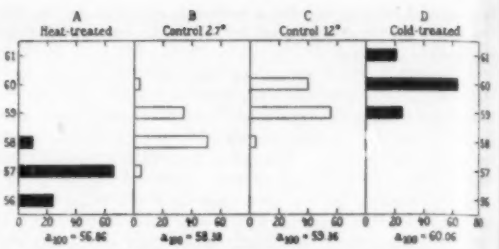
Influence of the Environment on Number of Vertebræ in Teleostean Fishes

For some years now it has been known that the environmental conditions during the development of the fish embryo may exert an influence leading to the number of vertebræ of the offspring becoming different from the number in the parents. Very few experiments, however, have been made on this subject, which is of considerable interest both from the systematic point of view and in the use of racial investigations in applied fishery biology. On earlier occasions, for example, in *Nature* and elsewhere[1], I have referred to some experiments on the sea-trout dealing with this matter. On exposing the developing eggs to varied influences, especially by changing the temperature, we succeeded in determining the period when the temperature had a special effect on the number of vertebræ found later in the fry. The embryo was specially sensitive during a fairly short period, which was called the supersensitive period. A temperature-change of no great amount (3–6° C.) could in this period produce a difference of about 1·5 vertebræ, which is regarded as a great difference when found in so-called races of fish in Nature.

Starting from this result, it seemed, on both theoretical and practical grounds, advisable to try whether even greater differences could be produced in the average number of vertebræ in offspring of the same parents when the eggs in the specially sensitive period were exposed to even greater differences of temperature than used previously. The experiment was carried out on sea-trout in the winter of 1947–48, and the procedure was similar to that used earlier[1]. The eggs were exposed during the supersensitive period to a brief but considerable change of temperature (*c.* 10–13°), in such a way that the eggs which, for example, were developing at *c.* 12°, received *cold treatment* at *c.* 2·5° for about eight days (equal to *c.* 20 day-degrees), while those developing at a temperature of about 2·7° received *warm treatment* up to *c.* 16° for twenty-four hours (also equal to *c.* 20 day-degrees). After the cold or warm treatment, the eggs were returned to their original temperature, and their development proceeded until the young were old enough for the final number of vertebræ to be determined exactly by means of Alizarine staining and clearing.

Experimenting in this way during the supersensitive period, it was found that differences of no less than 3·2 vertebræ could be produced in the average number of vertebræ in offspring of the same parents. The accompanying diagram shows the results of this experiment, the results for the warm and cold treatment being respectively to the left and right (*A* and *D*) of the control samples (*B* and *C*).

In this species the number of vertebræ varies between 56 and 61, and the treatment has brought out the surprising result that, although they are offspring of the same parents, no variant is common to the samples of cold- or heat-treated specimens. In our long series of experiments, whether with quite small or large temperature changes, there is nothing to indicate that the genetic basis in the specimens treated has changed in any way, that is, the alterations are only phenotypic responses to environmental conditions.



Number of vertebræ in offspring of the same parents (sea-trout), which were subjected during the supersensitive period of the embryonic development to heat (left) and cold (right), both of short duration. The values for the control samples are shown in the middle (*B* and *C*), and the average number of vertebræ (100 specimens) is given under each sample (both parents had 57 vertebræ). *A*: *heat-treated sample*; reared at 2·7°, but transferred to 16° during a period of 20 day-degrees (from the 147th day-degree to the 167th day-degree); *D*: *cold-treated sample*; reared at 12°, but transferred to 2·5° during a period of about 20 day-degrees (from the 143rd day-degree to the 165th day-degree)

It is worth noting here that a variant distribution almost corresponding to the low values of the heat-treated samples is found in Nature at the southern boundary of the distribution of the trout (for example, in Italy), whereas in northern countries, at its northern limit, the higher variants are dominant. As is known, the southern forms of trout are described as special species or races.

Our experiments have thus produced modifications (comparable to the so-called phenocopies) among offspring of the same parents, which systematists of a generation ago would presumably have taken for separate species, if their origin had been unknown. Similar surprising results have also been found in other meristic characters (fin-rays) in the sea-trout, and these results indicate that one must be careful in using differences in meristic characters in fish populations for taxonomic purposes, even though such differences naturally *may* be due to genetic diversities.

I shall, however, not discuss the results of these and other experiments in further detail here; a report on them will be published elsewhere.

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[1] Tåning, *Medd. Komm. Danmarks Fiskeri- og Havunders., Fiskeri*, **11**, 3 (1944); *Nature*, **157**, 594 (1946).

D.D.T. and 'Gammexane' as Residual Insecticides against *Anopheles maculatus* in Malaya

Muirhead-Thomson[1] has reported on the use of an experimental hut with a light-trap fitted into the window, as a method of assessing the efficiency of the residual insecticides D.D.T. and 'Gammexane' against *Anopheles gambiæ* in Africa. Similar experiments have recently been conducted against *A. maculatus*, the principal vector of malaria in Malaya. Unlike *gambiæ*, *maculatus* normally leaves houses at or before dawn to rest out of doors by day, and nearly all those captured in an untreated experimental hut were found in the light-trap in the morning.

A preliminary trial with wettable powders of D.D.T. (Stafford Allen's 33 per cent at 100 mgm. D.D.T./sq. ft.) and benzene hexachloride (I.C.I.'s *P*.530 at

20 mgm. γ-benzene hexachloride/sq. ft.), was relatively unsuccessful, due in part to the small numbers of mosquitoes recovered. The internal linings of the two experimental huts were then replaced in preparation for a second trial, in which the insecticides were applied at double the previous dose, that is, D.D.T. at 200 mgm. per sq. ft. and benzene hexachloride (this time *P*.520) at 40 mgm. γ-isomer per sq. ft.; a third untreated hut served as a control.

Fortunately this second trial coincided with the seasonal increase in abundance of *maculatus*, and satisfactory numbers entered each hut to feed on the man sleeping inside. The results during twelve weeks of this trial are briefly indicated in Table 1. Observations are still in progress, and the final results will be reported in full elsewhere.

Table 1. Effect of insecticides upon *A. maculatus* entering trap-huts during twelve weeks after treatment.

Hut	Number recovered	Initial mortality*		Mortality 24 hr. later		Blood-fed		In light-trap		In hut	
		No.	%	No.	%	No.	%	No.	%	No.	%
D.D.T.	341	219	64	294	86	274	80	225	66	116	34
B.H.C.	269	236	88	266	99	138	51	212	79	57	21
Control	426	8	2	92	22	383	90	408	96	18	4

* Number found dead in hut and light-trap at 8 a.m.

D.D.T. Although this had a little effect in reducing the proportion of *maculatus* biting, 64 per cent of the total recovered each morning were dead, and of the remainder captured alive in the light-trap and then maintained in an insectarium, 61 per cent died within 24 hr., giving an overall mortality after 24 hr. of 86 per cent. The corrected mortality after 24 hr., using Abbott's formula[2], was 82 per cent. There was no evidence of any decline in this mortality during the twelve weeks.

Benzene Hexachloride. No active living *maculatus* were recovered, though a few of those which entered the light-trap lingered on for 24 hr. in a moribund condition. There was a very marked reduction in the proportion biting, and many of the unfed mosquitoes were found dead in the light-trap, suggesting that they had been driven out of the hut by the effects of the insecticide.

Effect on Culicines. Large numbers of culicines, mostly *Culex fatigans*, entered the huts, and observations were made on the mortality and behaviour of these. The numbers entering and the mortality occurring are shown in Table 2, summarized in periods of four weeks.

Table 2. Mortality among Culicines (mostly *C. fatigans*) entering trap-huts

Period in weeks	Control hut			D.D.T. hut			Benzene hexachloride hut		
	Entered	Dead		Entered	Dead		Entered	Dead	
		No.	%		No.	%		No.	%
1– 4	547	3	0·5	491	64	13	626	526	84·0
5– 8	1,519	34	2·2	1,352	78	5·8	1,397	556	39·8
9–12	867	31	3·6	1,026	80	7·8	617	135	22·0

D.D.T. caused very little mortality, but had an irritant effect, driving the mosquitoes from the hut into the light-trap, and reducing the biting-rate. Benzene hexachloride caused a very high mortality in the period immediately following treatment, falling off gradually over the twelve weeks of the observations. Like D.D.T., it reduced the biting-rate, though to a greater extent, and drove the mosquitoes into the light-trap.

These results agree with Muirhead-Thomson's in showing the great effectiveness of benzene hexachloride, but differ in showing D.D.T. to be lethal to *maculatus*, whereas it was ineffective against *gambiæ*. The effect of D.D.T. on *Anopheles gambiæ* and *Culex fatigans* seems to be rather similar. A large proportion of both species normally rests indoors by day, and in an untreated trap-hut the greater proportion is found each morning in the hut, not in the light-trap; but when D.D.T. is applied the reverse is true. Both species seem to be readily irritated by D.D.T. and driven out of the hut; but few are killed. No irritant effect can be detected in this way for *maculatus*, because its normal habit is to leave the hut. Benzene hexachloride drove a large proportion of *C. fatigans* into the light-trap, but not before many of them had received a lethal dose.

These experiments suggest that both D.D.T. and benzene hexachloride should be effective as residual insecticides against *Anopheles maculatus* in Malaya.

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Aug. 8.

[1] Muirhead-Thomson, R. C., *Nature*, **163**, 109 (1949).
[2] Abbott W. S., *J. Econ. Ent.*, **18**, 265 (1925).

Growth of Mangels and Long Beet

Numerous observers must have noted in crops of mangels that, attached to portions of the storage organs of these plants, well above soil-level, were numerous lateral roots, hanging in the air and having no contact with the soil. Other lateral roots though still embedded in the soil may have their point of origin several inches above soil-level. Percival[1] points out that in some varieties of mangels the hypocotyl grows up out of the ground. Upward growth of the hypocotyl will not, however, elevate above the soil lateral roots which arise below the level at which the seed was sown. In fact, it is clear in many cases that these lateral roots are raised by the upward growth of the true main root.

In seedlings and young plants lateral roots arise in two ranks and are close together, and they remain so in those varieties which show relatively little elongation of the storage region or in which this elongation is confined almost entirely to the hypocotyl. In some 'long' and 'intermediate' varieties a phase of elongation appears to set in which involves an already thickened portion of the true root which bears well-developed lateral roots, and by upward growth lifts many of them out of the soil. This condition is shown by the plant in Fig. 1 (var. 'Yellow Intermediate'), in which many lateral roots have been torn from the soil by the elongation of a thickened portion of the main root. Fig. 2 shows two plants of the variety 'Red Intermediate' cut longitudinally. In the left-hand plant little elongation, except of hypocotyl, has occurred, and the lateral roots are seen to be crowded together near to the base. In the plant on the right, elongation of the thickened region of the root has occurred and the lateral roots are seen to be widely separated, many of them being lifted above soil-level. Sometimes this elongation is so great as to cause a disruption of some of the older central tissues of the storage organ (Fig. 3). This

Photo: P. Chambers

Fig. 1. 'Yellow Intermediate' mangel. The base of the photograph represents soil level. Note lateral roots (the largest marked with an arrow) above soil-level

'lifting' of the roots is frequently preceded by some wilting of the foliage, and the older leaves of the plant may remain in a wilted condition for several weeks or even permanently. We must assume that this wilting (which occurs irrespective of climatic or soil drought) is caused by the severance of some of the lateral roots from intimate contact with the soil, as the swollen part of the main root commences its elongation.

This wilting is even more marked in the two varieties of long garden beet, 'Exhibition Black' and 'Cheltenham Green Top', than it is with any of the types of mangels observed. These two green-leaved varieties of long beet, with us, invariably exhibit a wilting of the foliage, the former variety about July 25–28, and the latter variety approximately a week later. With the variety 'Exhibition Black', the wilting is followed after an interval of about ten days by the appearance of the 'root' above soil-level. The wilting is not due to a soil-water deficit. Its onset may coincide with a period when the soil is wet and heavy rain falling. Further, the wilting occurs two to three days earlier when the plants are widely spaced (approximately two plants per foot of row), and consequently large, than when they are more closely spaced (approximately four plants per foot of row), although competition for soil water is likely to be most acute when the plants are closely spaced. With these beet any subsequent upward elongation is due mainly to hypocotyl growth, although frequently sufficient elongation of the thickened portion of the root occurs to lift a few lateral roots out of the soil. As with mangels, we can only assume that the wilting results from an interruption of the intimate contact formerly existing between lateral roots and the soil, so that irrespective of the water content of the soil, insufficient water absorption occurs to maintain all the foliage in a state of turgidity.

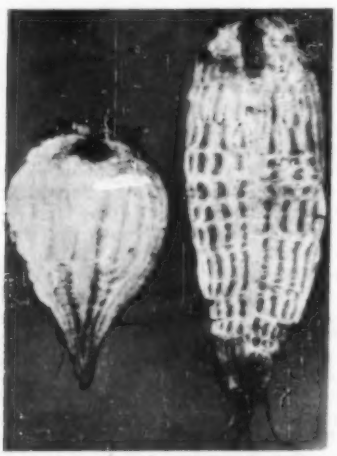

Photo: P. Chambers

Fig. 2. 'Red Intermediate' mangels, cut longitudinally. In the plant on the right, elongation of the main root has occurred and the lateral roots are well separated. In the plant on the left, elongation is confined almost entirely to the hypocotyl, and the lateral roots are crowded together near the base of the storage organ. (Photographed July 27, 1949)

Photo: P. Chambers

Fig. 3. 'Golden Tankard' mangel, cut longitudinally. Elongation of the storage organ has resulted in disruption of some of the older tissues. (Photographed July 27, 1949)

The beet plants which wilt in this way never completely recover, but remain with their older leaves permanently wilted. The two varieties of beet which exhibit this character are also (with us) marked by the 'clean' roots they produce, that is, the absence of strongly developed lateral roots. Six other varieties of long garden beet ('Selected Purple', 'Dells Blackleaved', 'Non-Bleeding', 'Exhibition Crimson', 'Fine Dark Red', 'Covent Garden Red') grown for purposes of comparison did not exhibit any wilting of the foliage, and many of these varieties do develop strong lateral roots. Whether the association of green leaves, absence of strongly developed lateral

roots and wilting is more than fortuitous cannot be said. Neither can we say whether the wilting which occurs is indicative of an internal water deficit sufficiently serious to restrict growth. It is noteworthy that one of the varieties concerned ('Cheltenham Green Top') is a popular variety among commercial growers and hence is presumably at least not markedly inferior to other varieties in its cropping capacity.

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Nov. 11.

[1] "Agricultural Botany", London (1910).

A Technique for Studying Infection of *Dracunculus* in *Cyclops*

THE study of the relative infectivity of *Dracunculus* larvæ in various species of *Cyclops* which we undertook at the Department of Parasitology in the University College, Ibadan, involved the examination of thousands of *Cyclops*. Ordinarily there are two ways of identifying infected *Cyclops*: to examine them alive, which could be done if one is dealing with a few specimens; or, when large numbers have to be dealt with, to stain them in bulk and then examine them, one by one, later.

A live infected *Cyclops* in a drop of water on a slide is easily recognized with the low power of the microscope because of the vigorous lashing movement of the *Dracunculus* larvæ (it is rare to find only one larva in an infected *Cyclops*) inside the body cavity. It is necessary to immobilize the *Cyclops* temporarily by some means to stop it darting about on the slide. The substance used for this purpose must be such as will have no effect on the larvæ inside, for if these, too, are immobilized their identification will be difficult, especially in the breeding season when the body cavity of the *Cyclops* is generally filled with large coloured dense cells which will later give rise to eggs or spermatophores.

A few drops of 10 per cent alcohol added to about a dozen *Cyclops* in 2 c.c. of water in a watch-glass generally produce the required effect in two minutes and keep them in that state for about five minutes while the *Cyclops* are examined individually under the microscope. One has to make sure of the exact quantity of narcotizing material used, since if this is too weak the *Cyclops* do not stay immobilized long enough, while, if too strong, they will be permanently adversely affected later, on their return into the culture jar.

The method of staining works well if, after fixing the *Cyclops*, they are kept in a jar of 5 per cent caustic potash for 24 hours before staining. If this is not done, the staining will fail to show up the larvæ because the overlying muscle bands in the cephalothorax of the *Cyclops*, taking up the stain better than the larvæ underneath, will obscure them.

Both methods involve individual examination of the *Cyclops*, so that, apart from being very tedious, they are not suitable when numbers running into thousands are to be dealt with in a short time.

Recently, while working on the effects of low temperature on infected *Cyclops*, it was observed that the chill-coma temperature of *Cyclops* was 10° C. while that of *Dracunculus* larvæ was 7·5° C. (Details of this work are reported elsewhere.) Thus at any temperature between 7·5° and 10° C. the *Cyclops* are effectively immobilized while the contained larvæ are active and moving about, and, as such, are spotted without any difficulty. This, therefore, provides a method of rapidly counting the number of infected *Cyclops* in a dish containing more than a hundred. All that is necessary is to put into this dish sufficient crushed ice to cool the water to, say, 8° or 9° C., while a count is made with a binocular microscope, or, if desired, a separation into infected and uninfected groups is effected. *Cyclops* treated in this way suffer nothing and can undergo the same treatment several times without any apparent harm.

If it is not necessary to keep the *Cyclops* alive after the count is made, a more convenient way is to put them in a refrigerator for 24 hours. A few minutes after returning them to room temperature the larvæ will be seen to be moving about vigorously in the infected *Cyclops*, while any of the latter that have not already been killed by the cold can only resume normal activity after several hours.

The advantages of using the differential chill-coma temperature method in studying *Dracunculus* infection in *Cyclops* are four-fold, namely: (1) it enables one to deal with more than a hundred *Cyclops* in a dish at once instead of examining them one by one on a slide; (2) it eliminates the risk of under- or over-narcotizing the *Cyclops*, as often happens when 10 per cent alcohol or some other narcotic is used; (3) when the temperature is merely reduced to about 8° C., the *Cyclops* can be returned to the culture jar without any ill-effects after a count is made; (4) the process is very easy to carry out.

A similar technique may be applicable in the study of other parasitological problems.

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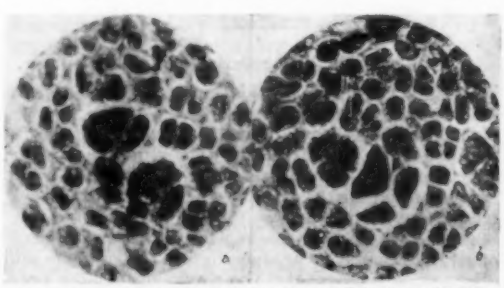
Apical Cell of Salt Marsh Fucoids

I HAVE been studying the anatomy of the British salt marsh fucoids under the direction of Prof. V. J. Chapman. While Prof. Chapman was at Manchester in 1946, Prof. I. Manton, as a matter of interest, examined the apical cell of *Fucus vesiculosus ecad volubilis* and found that it was in the three-sided juvenile state. On this basis, Prof. Chapman in his book "An Introduction to the Study of the Algæ" surmised that the three-sided juvenile condition of the apical cell may be common to all marsh forms of the fucoids, and this has proved to be correct.

The accompanying photomicrographs are of *Pelvetia canaliculata ecad libera* and *Ascophyllum nodosum ecad scorpioides*, and show clearly the three-sided apical



Transverse section of apical cell (× 200): (*a*) *Pelvetia canaliculata ecad libera*; (*b*) *Ascophyllum nodosum ecad scorpioides*

cell. Similar photographs are available showing a three-sided apical cell in *Fucus spiralis* var. *nana*, *Pelvetia canaliculata ecad coralloides*, *Fucus ceranoides megecad limicola*, *Fucus vesiculosus ecads cæspitosus* and *muscoides*.

It is now suggested that the lack of sexual reproductive organs in these marsh fucoids is not so much a matter of their environment, as suggested by Baker and Bohling[1]; but is instead a direct result of the retention of the juvenile apical cell. It may be supposed that the juvenile three-sided cell does not produce the growth-substance that stimulates the formation of sexual reproductive organs, or alternatively it may produce an inhibitor to the reproductive growth-substance. It would be interesting if workers in Great Britain were to study this aspect with the view of its confirmation or otherwise.

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July 24.

[1] *J. Linn. Soc. London*, **43** (1916).

A Decline of Citrus Plants in Venezuela

DURING the past year, the survey of a number of small *Citrus* groves has led me to conclude that a disease similar to "tristeza" is present in Venezuela, chiefly in the States of Carabobo and Aragua up to Sucre; western areas were not investigated. The disease has been previously attributed, by local agronomists, to high or deficient soil moisture or to an unclassified root injury, for the decay of rootlets, then of larger roots, occurs simultaneously with decline of the tops.

The symptoms are closely allied to the "podredumbre de las raicillas", described in Argentina, or "tristeza" of Brazil; the same disease has been found in Uruguay, and eventually in California[1].

In Venezuela, the disease has been recognized only when citric plants were cultivated on a commercial scale, and when sweet orange, local or introduced, was grafted on sour rootstock. (A peculiar die-back, of doubtful etiology, has been occasionally observed, for example, near Valencia, also on ungrafted sweet orange, at first with leaf yellowing, also with some vein yellowing and stunting of the young tree.)

As a rule, symptoms of the disease are later obscured by the interference of other causes of decline.

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July 7.

[1] Benett, C. W., and Costa, S. A., *J. Agric. Res.*, **78**, 207 (1949).

Oxidation of Catechol by Tea-Oxidase

DURING the enzymic oxidation of catechol, approximately two atoms of oxygen are taken up for each molecule of catechol, whereas only one atom is required for oxidation to the *o*-quinone stage. Wagreich and Nelson[1] consider this extra uptake to be accounted for by the interaction of the *o*-benzquinone with water to form 1 : 2 : 4-trihydroxybenzene, which then reacts with a further molecule of *o*-benzquinone to produce hydroxy *o*-quinone and a molecule of catechol. Their evidence that a polyphenol is produced from *o*-benzquinone, capable of being oxidized to an *o*-quinone by tyrosinase, is convincing. That the polyphenol produced is identical with catechol cannot be taken as established. The scheme has also been strongly criticized by Wright and Mason[2].

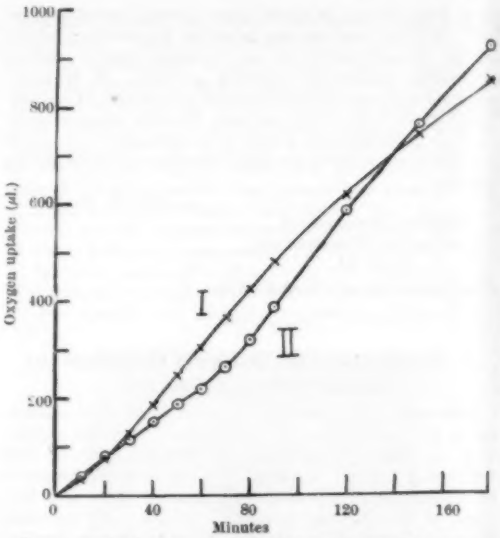

Fig. 1. Oxygen uptakes. I. 40 mgm. washed enzyme + 11 mgm. catechol at *p*H 5·6. II. 40 mgm. washed enzyme + 3 mgm. ascorbic acid

We have studied catechol oxidation by the tea-oxidase, and some of our experimental results are at variance with the Wagreich and Nelson mechanism of catechol oxidation.

Using an enzyme preparation of acetone-dried tea leaf, washed exhaustively with water to remove adsorbed polyphenols, the oxygen uptake curve with 11 mgm. catechol at *p*H 5·6 is autocatalytic (Figs. 1 and 2). As *o*-benzquinone is not autoxidizable[1], it seems likely that this autocatalytic rate is due to the production of a polyphenol, formed as an oxidation product of catechol, which is more rapidly oxidized

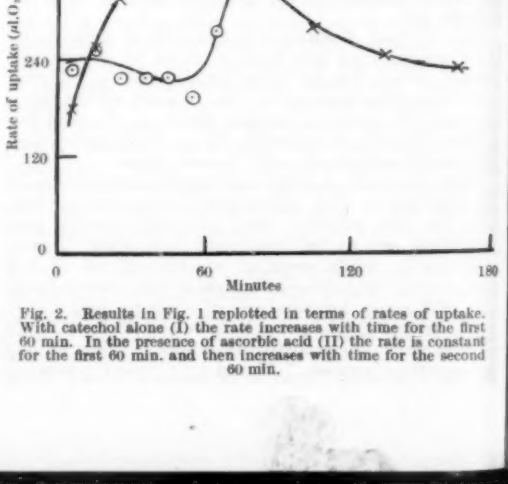

Fig. 2. Results in Fig. 1 replotted in terms of rates of uptake. With catechol alone (I) the rate increases with time for the first 60 min. In the presence of ascorbic acid (II) the rate is constant for the first 60 min. and then increases with time for the second 60 min.

Oxygen uptake (μl.) with 40 mgm. water-washed, acetone-dried tea-oxidase at *p*H 7·2 (phosphate)

Substrate	10	20	30	40	50	60 min.
15 mgm. catechol	37	82	127	175	213	256
„ + 3 mgm. ascorbic acid	24	53	80	110	135	161

by the tea-oxidase than catechol. Tyrosinase presumably oxidizes this new polyphenol at a lower rate than catechol, so that in this case an autocatalytic uptake curve is not obtained.

Support for this view is provided by the results observed when ascorbic acid is added to the system. In the presence of ascorbic acid, the rate of uptake is linear and at a significantly lower level than when no ascorbic acid is present. Reduction of the *o*-quinone, immediately on its formation, prevents the formation of the more rapidly oxidized polyphenol, so that the rate observed is that of catechol oxidation alone, uncomplicated by the formation of a more rapidly oxidized substrate. When all ascorbic acid is oxidized (3 mgm. = 190 μl.) the *o*-quinone is no longer reduced and the reaction-rate then becomes autocatalytic (Figs. 1 and 2).

At *p*H 7·2 the *o*-quinone is much less stable than at *p*H 5·6, and formation of the new polyphenol is more rapid. Consequently, a slow building up in the rate of oxygen uptake is less likely, and the rate shows only slight acceleration with time. On the other hand, the proportion of the uptake due to oxidation of the second polyphenol is greater in the initial stages, so that ascorbic acid produces a greater inhibition of the rate of uptake, as shown in the accompanying table.

Neither the autocatalytic rate of uptake at *p*H 5·6, nor the depression of the rate of uptake in the presence of ascorbic acid, can be accounted for if catechol is regenerated as a result of the disappearance of *o*-benzquinone from the system. On the other hand, these observations find a complete explanation if, instead of catechol, another polyphenol, oxidized more rapidly by tea-oxidase, is formed as a product of *o*-benzquinone. We cannot at present identify this polyphenol, although there is nothing in our results to exclude the possibility that it may be 1 : 2 : 4-trihydroxybenzene. In this case our mechanism differs from that of Wagreich and Nelson only in that the trihydroxybenzene is oxidized enzymically and not by *o*-benzquinone.

Further details of this work will be published elsewhere later.

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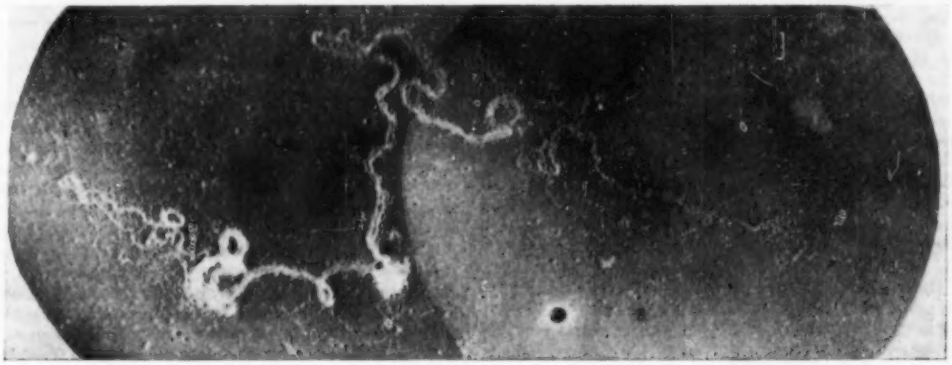
June 29.

[1] Wagreich, H., and Nelson, J. M., *J. Amer. Chem. Soc.*, **60**, 1545 (1938).
[2] Wright, C. I., and Mason, H. S., *J. Biol. Chem.*, **165**, 45 (1946).

Electron Micrograph of a Chromosome of *Triton*

Developing further the technique employed in our laboratories by Zalokar[1], we have obtained in our electron microscope (Trüb Täuber, electrostatic) a very large number of pictures of chromosomes of the ovocytes of *Triton*. The accompanying reproduction shows a typical one. These chromosomes were fixed with acetic acid and 'microcentrifuged'[2] on the collodion membrane.



Chromosome (or part of it) centrifuged on collodion membrane, gold-shadowed and enlarged 10,000 times

M. Danon
E. Guyénot

Laboratoire de Zoologie,

E. Kellenberger
J. Weigle

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University of Geneva.
July 18.

[1] Dinichert, Guyénot and Zalokar, *Rev. Suisse de Zoologie*, **54**, 283 (1947).
[2] Kellenberger, *Experientia*, **6**, 253 (1949).

Anterior Pituitary Explants of Infantile Rats Grafted in the Anterior Eye Chamber of Hypophysectomized Hosts

In an earlier communication[1], we have shown that hypophysectomized rats, irrespective of the length of time during which they were hypophysectomized, responded to pieces of the anterior pituitary introduced in the anterior chamber of the eye by a prompt resumption of growth. Some such grafted pieces of the anterior pituitary survived for periods of sixteen months, showing signs of their activity, as reflected by the growth of the host animal, during all that time. Two animals with sixteen-months old grafts are still alive and still growing.

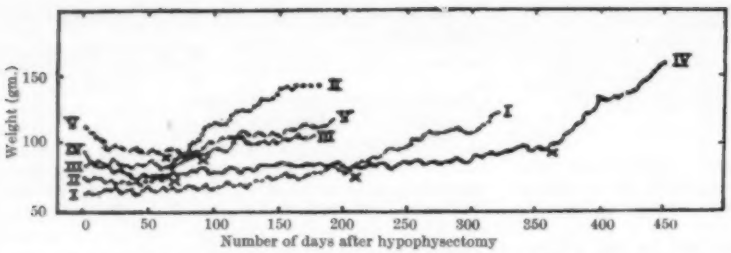

Fig. 1. Curves of growth of five hypophysectomized rats with explant grafts. ×, Day on which graft was implanted in eye

In our earlier publications[2], we have shown that pieces of the anterior pituitary of infantile rats can survive *in vitro* in equal parts of chicken plasma and chicken embryo extract at 34° C. for as long as four months. Two months old explants grafted in the anterior eye chamber of normal hosts lived there for several weeks; when sectioned and stained, they did not differ much from pituitary grafts taken directly from the donor.

The object of the present experiment was to find out the fate of cultures, capable of remaining active for a long period, of pieces of the anterior pituitary if grafted into the anterior eye chamber of hypophysectomized hosts.

Pieces of the anterior pituitary of infantile rats (12–18 days old) were cultivated by the watch-glass technique in rat plasma, chicken plasma and chicken embryo extract in the proportion of 6 to 3 to 3 at 34° C., the medium being changed every seventh day. All the explants showed visible signs of activity. They vigorously liquefied the plasma medium, especially during the first three weeks. An appreciable number of cells migrated into the surrounding medium. Migration of cells from the mother tissue in some cases continued for as long as seven weeks. That some of the migrating cells must have been parenchyma cells there can be little doubt; but our interest was centred upon the mother explant itself. After 32 days of cultivation, the explants (six to twelve in number), each of them consisting of what was left of one half of the anterior lobe, were grafted in the anterior eye chamber of five hypophysectomized hosts, whose age at hypophysectomy, duration of the hypophysectomized state and the duration of life following grafting are shown in Fig. 1.

All these five animals, as can be seen from the curves of their growth before and after the grafting operation was performed, like animals with pituitaries transplanted directly from the donor, gave an *immediate* response to the grafted explants by a sudden resumption of their process of growth. This rather unexpected reaction found what is most likely its logical explanation when control-pieces of the anterior pituitary kept *in vitro* for 32 days and longer were sectioned and specifically stained; in this case the Severinghaus technique was used. In the stained preparations, it was observed that the mother explant contained a large number of acidophile cells, besides an even larger number of neutrophiles, which stained just as intensely and as beautifully as do the cells of the same type taken directly from a normal fully grown donor (Fig. 2). These cells in sectioned preparations usually occupy a band-like area between the necrotic centre and a thin layer of surface cells devoid of colloidal granules.

After six and seven weeks of cultivation, the whole explant begins to show signs of degeneration; but in some of the explants healthy-looking acidophile cells were found after sixty-five days of their *in vitro* life. A fair number of damaged acidophiles and a few healthy-looking cells of the same type were observed even after eighty-three and ninety days of cultivation (Fig. 3). This shows that in our cultures acidophile cells were capable of surviving as long as the explant itself. No cells suggesting basophiles were to be seen in these cultures.

Explants grafted for three months in the anterior eye chamber of hypophysectomized rats, when sectioned and stained, were shown to contain a large number of intensely staining acidophiles, which was not the case with infantile pituitaries (12–16 days old) grafted directly from the donor. In the latter case the acidophiles were only faintly stained.

Hence this method gives a reliable and simple technique for the study of acidophile cells *in vitro*. Cultivated in chicken plasma, chicken embryo extract and rat plasma of adult animals at 34° C., these cells survive in a practically unmodified state for many weeks. A detailed report of this work will be published elsewhere.

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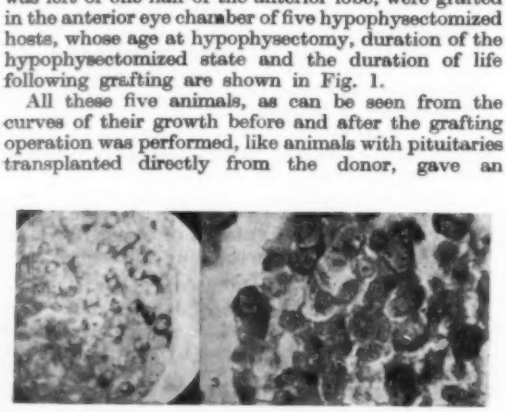

Fig. 2. Photograph of a 32-day-old *explant* of the anterior pituitary of an infantile rat. Acidophiles intensely stained. Stained with Severinghaus technique. × 225

Fig. 3. Photograph of 90-day-old *explant* of the anterior pituitary of an infantile rat. Four acidophile cells clearly visible. Stained with Severinghaus technique. Highly magnified

[1] Martinovitch, P. N., "Functional Pituitary Grafts in the Rat" (published in reprint form by the Serbian Academy of Science, June 20, 1949).
[2] Martinovitch, P. N., *Medicinski pregled*, 7 (1940).

Chemical Constitution of Slippery Elm Mucilage: Isolation of 3-Methyl D-Galactose from the Hydrolysis Products

THE mucilage obtained from the bark of the slippery elm tree (*Ulmus fulva*) was reported by Anderson[1] to occur as the partially methylated derivative (OMe, 4·6 per cent of the polysaccharide). From an investigation of the hydrolysis products of

the polysaccharide, he concluded that it contained D-galactose, L-rhamnose and D-galacturonic acid, and, in addition, he found indications which suggested the presence of a partially methylated aldose sugar and a pentose sugar. Later, Gill, Hirst and Jones[2,3] investigated the chemical structure of the mucilage by the methylation procedure; only the methylated derivatives of D-galactose, L-rhamnose and D-galacturonic acid were detected, however.

The identity of the material containing the methoxyl groups, and which occurs in the natural polysaccharide, was therefore unknown, and its separation and identification was attempted by the use of paper partition chromatography. The mucilage was hydrolysed in *N* sulphuric acid for nine hours with the formation of an aldobiuronic acid, designated as 2-D-galacturonosido-L-rhamnose[3], and a mixture of reducing sugars. After separation from the aldobiuronic acid, the mixture of reducing sugars (*A*) was separated into its components on a sheet of filter paper by partition chromatography[4]. From the rate of movement[5] of the sugars on the paper chromatogram and from the colours produced on spraying with aniline trichloracetate[6], α-naphthylamine trichloracetate[7], and diphenylamine trichloracetate[7] and subsequent heating, it was deduced that galactose, either 3-methyl galactose or talose, rhamnose and an unknown sugar (traces) were present.

Accordingly, a portion of the sugar mixture (1·2 gm.) was separated on a column of cellulose[8] by partition chromatography, using a mixture of *n*-butanol (95 per cent) and ethanol (5 per cent), nearly saturated with water, as the mobile phase. Using this technique, pure crystalline specimens of D-galactose, L-rhamnose and 3-methyl D-galactose were obtained on evaporation of the solvent. The identity of the 3-methyl D-galactose follows from the following observations.

(1) Its position on the paper chromatogram corresponds exactly with that of a known specimen of 3-methyl galactose (R_G 0·17). (2) $[\alpha]_D + 87°$ equilibrium value (*c*, 0·29 in water); OMe, 14·3 per cent (calc. for $C_7H_{14}O_6$. OMe, 16·0 per cent). (3) The change in optical rotation of a solution of the methyl galactose in 4 per cent methanolic hydrogen chloride from a positive value ($[\alpha]_D + 62°$) to a negative value ($[\alpha]_D - 43°$), thus indicating the presence of a free hydroxyl group on C_4. (4) M.p. 140–141°, undepressed on admixture with an authentic specimen of 3-methyl D-galactose. (5) An X-ray powder photograph of the crystals was identical with that of 3-methyl D-galactose.

The detection of 3-methyl D-galactose in a natural product is unique, as in the case of the isolation of D-tagatose from *Sterculia setigera* gum[9], and again serves to illustrate the utility of paper partition chromatography for the analysis of the complicated mixtures arising from the hydrolysis of polysaccharides.

Quantitative analysis[10] of the sugars (*A*) produced on hydrolysis of the gum showed the presence of galactose, 20·8 per cent (calc. as $C_6H_{10}O_5$), 3-methyl galactose, 19·1 per cent (calc. as $C_7H_{12}O_5$) and rhamnose, 7·9 per cent (calc. as $C_6H_{10}O_4$).

We wish to thank Prof. T. Reichstein for a specimen of 3-methyl D-galactose and Dr. T. Malkin for carrying out the X-ray examination.

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Aug. 3.

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[2] Gill, R. E., Hirst, E. L., and Jones, J. K. N., *J. Chem. Soc.*, 1469 (1939).
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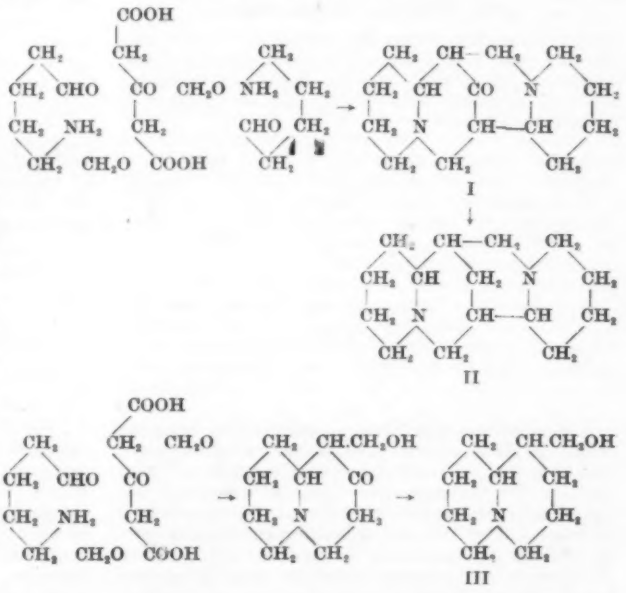
[4] Partridge, S. M., *Biochem. J.*, **42**, 238 (1948).
[5] Hirst, E. L., Hough, L., and Jones, J. K. N., *J. Chem. Soc.*, 928 (1949).
[6] Partridge, S. M., *Nature*, **164**, 443 (1949).
[7] Hough, L., Jones, J. K. N., and Wadman, H., *J. Chem. Soc.* (forthcoming publication).
[8] Hough, L., Jones, J. K. N., and Wadman, W. H., *J. Chem. Soc.*, 2511 (1949).
[9] Hirst, E. L., Hough, L., and Jones, J. K. N., *Nature*, **163**, 177 (1949)
[10] Hirst, E. L., and Jones, J. K. N., *J. Chem. Soc.*, 1661 (1949).

A Synthesis of Sparteine

The scheme for the formation of sparteine suggested by Robinson[1] in his theory of the phytochemical synthesis of alkaloids is incorrect, being based on the then prevailing erroneous conception of its structure. Clemo, Raper and Short[2] have since shown clearly that the alkaloid must have the structure (II). However, a logical extension of Robinson's general ideas leads to the following formulations for the biosynthesis of sparteine (II) and lupinine (III).



In each case the last step is thought to proceed through the stages: reduction to an alcohol—dehydration—reduction. The condensation reactions suggested are obviously of the same kind as those proposed by Robinson for other alkaloids. Moreover, they clearly point to a close relationship between

iso-pelletierine, lupinine, cytisine and the alkaloids of the sparteine group. The latter are possibly derived from sparteine itself by oxidation, reduction and dehydration reactions.

A synthesis of *dl*-sparteine along these lines has now been effected. Acetone dicarboxylic acid and δ-aminovaleraldehyde (prepared by the mild acid hydrolysis of its acetal) were allowed to react in dilute aqueous solution at *p*H 13 at room temperature for several hours. Then, after adjusting the *p*H to 7, formaldehyde was added. From the reaction mixture 8-keto-sparteine (I) was isolated in 15–20 per cent yield, which on Clemmensen reduction afforded a nearly quantitative yield of *dl*-sparteine, identified by the melting points and mixed melting points with authentic specimens of several of its derivatives and by their analyses.

Further experiments on the synthesis of sparteine, lupinine and related alkaloids are in progress.

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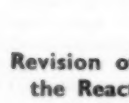
July 26.

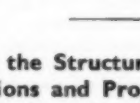
[1] Robinson, R., *J. Chem. Soc.*, **111**, 876 (1917).
[2] Clemo, G. R., Raper, R., and Short, W. S., *J. Chem. Soc.*, 663 (1949).

Revision of the Structural Interpretation of the Reactions and Properties of Certain Derivatives of Tetrahydrocarbazole and Related Compounds

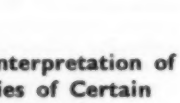
It is now known that all substances of the form (I), in which *A* is a saturated hydrocarbon residue, are yellow, fluorescing blue or violet in benzene or ethereal solution, and blue-green, or green, in hydroxylic solvents.



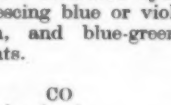
I



II



III



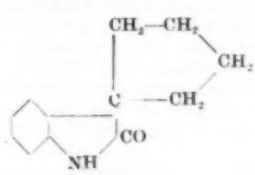
IV

Several substances have, however, been regarded as of type (I) which are colourless and non-fluorescent, and it is the object of this communication to point out that the evidence relied upon in these cases was inadequate and that a different formulation is necessary. For example, Bucherer and Grolée[1] submitted the anilino*iso*butyric acid of m.p. 185° to the action of sodium ethoxide and potassium hydroxide at 270–320° and obtained a colourless substance, $C_{19}H_{11}ON$, m.p. 150–151°, to which they attributed one of the structures (II) or (III). The properties of this compound suggest, however, that it is dimethyloxindole (IV), which has melting point 152–153°[2] or, less probably, 3-methyl-2-keto-1 : 2 : 3 : 4-tetrahydroquinoline.

This synthetic reaction was a model for the preparation of a series of substances such as the so-called pseudoindoxyl*spirocyclo*hexane[2], formulated like (II) because the alternative type (III) could here be eliminated as the result of parallel experiments in the hydro-acridine series.

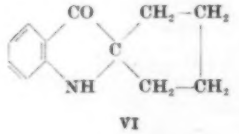
A re-examination of this and similar substances, and also of the so-called pseudoindoxyl*spirocyclo*pentane prepared from tetrahydrocarbazole[4] by a series of processes has convinced us that all of them are 3 : 3-disubstituted oxindoles. The hydrocarbostyril alternative is not rigidly excluded in some cases, but the preparation of stereoisomeric 5-keto-2 : 3 : 4 : 5 : 6 : 13-hexahydro-α-quinindones[5] shows that a hydroquinolone hypothesis is inapplicable to the so-called pseudoindoxyl*spirocyclo*pentane, which can only be oxindole*spirocyclo*pentane (V). The details will be published later; but it may be mentioned that the behaviour with alkalis, the fact that a primary amino-group can be liberated by hydrolysis under certain conditions, and the comparison of various reactions with those of undoubted 3 : 3-dimethyloxindole (IV), are regarded as quite conclusive. This positive evidence supplements the negative aspect that the substances under consideration are colourless and non-fluorescent, and hence are not dialkylated indoxyls.

The Bucherer–Grolée synthesis must be due to fission and recombination, and the former process was observed in the case of 1-anilino-*cyclo*hexanecarboxylic acid (cf. ref. 3).

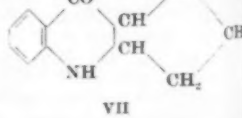


V

On the other hand, the so-called '11-hydroxytetrahydrocarbazolenine' of m.p. 79–80° (ref. 4) has all the properties of a substance of type I, and on this account must be the real pseudoindoxyl*spirocyclo*pentane (VI) or the hydroquinolone (VII).



VI



VII

It is of interest that this substance has also been obtained by the action of alkalis on tetrahydrocarbazole peroxide[6], and it may be that the later stages of the two processes are identical.

Pseudoindoxyl*spirocyclo*pentane (2 : 2-tetramethyleneindoxyl) (VI) has now been independently synthesized by treatment of N-acetylindoxyl under benzene and nitrogen with sodamide and tetramethylene chlorobromide, followed by alkaline hydrolysis of the product. The yield was very small and the purification difficult, probably due to the formation of substituted dibutylindoxyls and 1 : 2-tetramethyleneindoxyl. The small quantity of pure material eventually isolated crystallized from light petroleum in yellow needles m.p. 78–79°, alone or

mixed with the supposed 11-hydroxytetrahydrocarbazolenine.

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Nov. 15.

Bucherer and Grolée, *Ber. deut. chem. Ges.*, **39**, 991 (1906).
Plancher and Bettinalli, *Gazetta*, **29**, 1, 115 (1899).
Betts, Muspratt and Plant, *J. Chem. Soc.*, 1311 (1927).
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A Yellow Pigment Formed from *Para*-Aminobenzoic Acid and *Para*-Aminosalicylic Acid by Various Strains of *Mycobacterium*

We have previously shown that *para*-aminobenzoic acid is transformed into a yellow pigment by various species of mycobacteria[1,2,3]. The chemical composition of this pigment is unknown; but it has been established as an oxidation product of *para*-aminobenzoic acid. The pigment is insoluble in water and in most of the usual organic solvents, but is very soluble in phenol and glacial acetic acid. Various substances related to *para*-aminobenzoic acid, with the exception of procaine, were unable to form this pigment.

We have found, as with *para*-aminobenzoic acid, that *para*-aminosalicylic acid is transformed into a yellow pigment by *Mycobacterium smegmatis* and the closely related strain, *Mycobacterium tuberculosis* var. *hominis* No. 607, both of which organisms are naturally resistant to *para*-aminosalicylic acid. The conditions under which the *para*-aminosalicylic acid pigment is formed closely resemble those described for the formation of *para*-aminobenzoic acid pigment. It is noteworthy that replacement of glycerol by glucose strongly inhibits the formation of the pigment. In the presence of *para*-aminobenzoic acid, the biosynthesis of riboflavin by mycobacteria[4] is more rapid and the amount formed appreciably increased. *Para*-aminosalicylic acid has the same influence as *para*-aminobenzoic acid on the production of riboflavin.

Para-aminosalicylic acid pigment differs from the *para*-aminobenzoic acid pigment in several respects: (1) its colour is more reddish; (2) it is partially soluble in water and especially soluble in diluted acids and alkali; (3) it is much less stable than *para*-aminobenzoic acid pigment. The colour of the pigment rapidly changes to a dark brown within the first few days of growth.

Pigment production by *Mycobacterium smegmatis*

Pigment produced	Colour of pigment	No pigment produced
Para-aminobenzoic acid	Yellow	In addition to substances already mentioned (Mayer[3]):
Acetyl *para*-aminobenzoic acid	Yellow	*o*- and *m*-Aminobenzoic acid
Para-aminobenzoyl-diethyl-aminoethanol (procaine)	Yellow	*m*- and *p*-Hydroxybenzoic acid
Para-aminosalicylic acid	Orange-yellow	*o*-Hydroxybenzyl alcohol
Para-nitrobenzoic acid	Yellow	2,4-Dihydroxybenzoic acid
3,5 Dinitrobenzoic acid	Orange-yellow	*o*- and *m*-Phenylenediamine
3,5 Dinitrosalicylic acid	Orange-yellow	*m*-Aminophenol
Folic acid	Orange	2,4-Diaminophenol
		Acetyl derivatives of *o*-, *m*- and *p*-toluidine
	—	2,4,6-Triaminotoluene
		3 and 5-Nitrosalicylic acid

In the accompanying table are named a number of substances capable or incapable of pigment formation.

A great number of related substances had definite antibacterial activities. The following substances were bacteriostatic in concentrations of 0·025 per cent or greater: 3,4-diaminotoluene, 2,5-diaminotoluene, 2,4-diaminotoluene, catechol, resorcinol, *para*-phenylenediamine, *o*- and *p*-aminophenol, 1,2,4-triaminobenzene, *p*-aminoacetophenone.

In the presence of salicylic acid and acetyl salicylic acid, another pigment is produced which differs from the *para*-aminobenzoic acid pigment, as seen from its behaviour to fluorescent light.

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Carol Crane

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Summit, New Jersey. Aug. 5.

[1] Mayer, R. L., *Science*, **98**, 2539 (1943).
[2] Mayer, R. L., *J. Bact.*, **48**, 337 (1944).
[3] Mayer, R. L., *J. Bact.*, **48**, 93 (1944).
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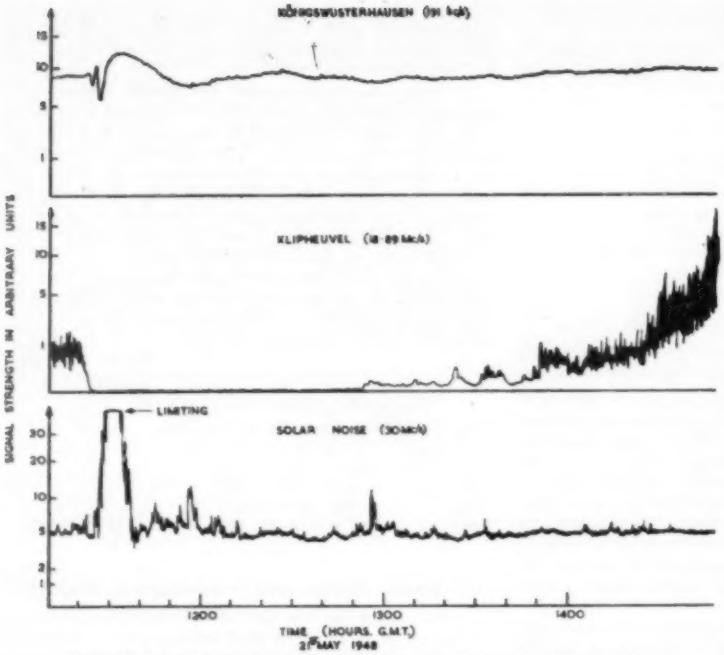
Solar Noise and Ionospheric Fading

A study of the correlation between the occurrence of bursts of solar noise and anomalies in ionospheric wave propagation was initiated at the Radio Research Station, Slough, by Mr. R. E. Burgess in 1948 and continued during that year by Messrs. C. S. Fowler and R. W. Mason. Some interesting effects on radio transmissions in the low-frequency band at times of sudden ionospheric disturbances have been observed.

In the course of this work simultaneous recordings were made of the relative intensity of solar noise at frequencies of 30, 42, 73 and 155 Mc./s. and of the strength of signals from the stations of Klipheuvel, South Africa, on 18·89 Mc./s., and Königswusterhausen, Germany, on 191 kc./s. On a number of occasions a burst of noise was accompanied by a complete fade-out (of the Dellinger type) of the high-frequency signal and a marked fluctuation in the level of the low-frequency signal. The most outstanding example occurred at about 1130 G.M.T. on May 21, 1948, at the time of a large solar flare which has already been reported[1]. The records for the two stations and for the noise on 30 Mc./s. are reproduced in the accompanying figure.

The main feature of the record to which I wish to direct attention is the variation of the low-frequency signal during the fade-out. As pointed out by Dr. B. G. Pressey, the nature of this variation is characteristic of interference between the ground and ionospheric waves caused by a change in the phase and amplitude of the ionospheric wave; and this could be explained by a change in the equivalent height of reflexion together with an increase in the effective reflexion coefficient of the ionosphere. Normally the intensity of the ionospheric wave from a low-frequency station at this distance (975 km.) is relatively small at noon; but the record shows a considerable increase of intensity over a period of ten minutes which is approximately the same as the duration of the noise burst. The relative phase-change during the disturbed period is seen to be about two cycles, which corresponds to a change in equivalent height of reflexion of about 10 km., if a



Records of signal strength of Königswusterhausen, Klipheuvel and solar noise

normal height of 80 km. is assumed. The return to normal conditions seems to be complete by the end of the high-frequency fade-out at about 1400 G.M.T.

Physically, this effect may be explained by the increase in ionization density producing a well-defined lower boundary on the reflecting region which, travelling rapidly downwards, reduces the equivalent height of reflexion and also decreases the length of the path of the wave through the lower absorbing levels.

It is to be noted that the start of the low-frequency anomaly and of the high-frequency fade-out occurs some five minutes before the burst of solar noise.

The work referred to above was carried out as part of the programme of the Radio Research Board, and this letter is published by permission of the Department of Scientific and Industrial Research.

R. L. SMITH-ROSE

Radio Research Station,
Ditton Park, Slough, Bucks.

Aug. 4.

[1] "A Brilliant Solar Flare, 21st May 1948", *Observatory*, **68**, 191 (1948). (Two letters, from H. Barton and H. W. Newton.)

Ionosphere and Weather

FOR some ten years, at the Zi Ka Wei Observatory, in Shanghai, China, we have been using, with exceptional success, a new technique in our weather forecasting. This method is based on an as yet unexplained correlation between the usual ionosphere echoes (*E*, *F* and F_2) and the future movement or behaviour of the three main air masses, which make the weather all over the world: polar, maritime and tropical, or equatorial, as some people call it. Our results have already been published in the *Bulletin of the Meteorological Society of America*, in 1946, and in a paper sent to the last Pacific Science Congress held in New Zealand last February.

We found, in 1939, in Zi Ka Wei that by pulsing on the mean critical frequency for the *E*-layer at our station (6 Mc.), any day of the year, after sunrise and before sunset, we could forecast what type of air mass would make the weather over an area of 400 km. around Shanghai. For example, we found that when we had an *E*-echo, the maritime (Pacific Ocean) air mass would either stay over us, if it was already there, or it would come over us, if at the time of pulsing another type of air mass was covering our regions. When we obtained an *F*-echo, the polar (Siberian) air mass would make the weather, while an F_2-echo meant the arrival of the tropical air, or its staying if already there. Knowing by this technique the type of air mass due to make the weather, we could forecast its future characteristics, dry or damp, overcast or clear, windy or calm, good or bad visibility, high or low temperatures, etc.

In frontal weather conditions, no echoes are obtained; that kind of weather would then continue for the next twenty-four hours.

When a typhoon had been located, on the weather map, at about 200 miles distance, an *E*-echo would show that the maritime air mass would bring the cyclone dangerously close to us. An *F*-echo would show that no danger was threatening the Shanghai area, since the typhoon would recurve.

We have tried this new technique in Hong-Kong, with the generous help of Mr. S. P. Heywood, director of the Royal Observatory, during the last typhoon season and have obtained results just as good as those mentioned for Shanghai.

It would be very interesting to see if also in Britain such a weather forecasting technique would yield the same results. All that is required is a self-oscillating radio circuit, with an output of about 100 watts. The pulsing should be obtained by using a special grid leak, namely, a very good 0·01-μF. fixed condenser with a 2-MΩ fixed resistor in parallel. Any good communications receiver, without the usual transformer output, connected to an ordinary cathode-ray oscillograph, would show the ionospheric echoes.

Weather maps to be consulted should be drawn according to the types of air masses and not to show only the high- or low-pressure values. The values of these pressures do not show the kind of weather prevailing in these high or low areas.

If two different echoes show in the screen of the oscillograph, most attention should be given to the more dominant type.

E. GHERZI, *S.J.*
(Director for Meteorology and Seismology)
Zi Ka Wei Observatory, Shanghai.

Relief of Internal Stresses by Precipitation

During an investigation of the recrystallization of two-phase silver–magnesium alloys, it has been observed that precipitation occurring in one of the phases, after deformation but before recrystallization, increases the temperature at which recrystallization starts in that phase.

This was shown in the following way. A silver alloy containing 31·8 atomic per cent magnesium (9·5 weight per cent) was water-quenched from 600° C., and an alloy containing 32·3 atomic per cent magnesium (9·7 weight per cent) was slowly cooled to 300° C. and quenched to room temperature. Both alloys, which then contained almost identical volume fractions of the two phases, were deformed by drawing to 80 per cent reduction in area and annealed at 350° C. for 30 min. During this annealing, the crystals of the α-phase recrystallized fully in both alloys. The crystals of the β-phase were almost fully recrystallized in the slowly cooled alloy, but showed no sign of recrystallization in the quenched alloy. Heavy precipitation of the α-phase occurred in the β-crystals of the quenched alloy, giving rise to a Widmanstätten structure, but no precipitation occurred in the slowly cooled alloy. This is shown in the microstructures, Fig. 1, *a* and *b*. The fact that precipitation occurred in the quenched but not in the slowly cooled alloy is in agreement with the phase diagram of the silver–magnesium system[1].

Fig. 2 shows the back-reflexion X-ray diagrams of the two alloys after annealing at 350° C. The inner ring is the 330 Debye–Scherrer circle of the β-phase and the outer ring is the 333 Debye–Scherrer circle of the α-phase. The top portion (Fig. 2, *a*) is half the diagram of the slowly cooled alloy; it shows a spotted ring of the β-phase, indicating practically complete recrystallization of this phase. The lower part (Fig. 2, *b*) is half the diagram of the quenched alloy. Here the Debye–Scherrer circle of the β-phase is still continuous, which shows that no recrystallization has occurred; however, the sharpness of the ring indicates that the internal stresses which had been present in the alloy due to the plastic deformation and had given rise to line broadening have been relieved.

When specimens of the deformed alloys were annealed at 300° C. the β-phase did not recrystallize in either case, and the β-lines in the X-ray patterns were broad, due to the deformation. These lines were sharper, however, in the diagram of the quenched alloy. Precipitation had occurred in this alloy but not in the slowly cooled alloy.

The conclusion is drawn from these experiments that the precipitation occurring in the quenched alloy is responsible for the relief of the internal stresses, thus reducing the tendency for recrystallization.

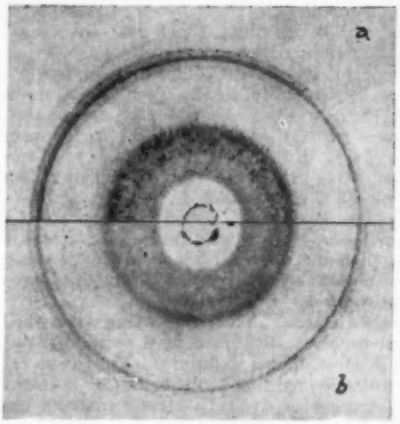


Fig. 2. Back-reflexion X-ray diagrams of alloys annealed at 350° C. (*a*) Slowly cooled alloy; (*b*) quenched alloy

An explanation of this effect seems possible in terms of the dislocation theory. The dislocations in the deformed β-phase diffuse to the regions of misfit at the new boundaries created by precipitation, where they are no longer effective in causing internal stress. Cahn[2] suggests a similar movement of dislocations for stress relief by polygonization.

The work described in this paper was carried out as part of the research programme of the Division of Tribophysics, Commonwealth Scientific and Industrial Research Organisation.

L. M. Clarebrough

Division of Tribophysics,
Commonwealth Scientific and
Industrial Research Organisation,
University of Melbourne, N.3.

Aug. 2.

[1] Andrews, K. W., and Hume-Rothery, W., *J. Inst. Metals*, **69**, 485 (1943).

[2] Cahn, R. W., Phys. Soc., Rep. Conf. on Strength of Solids, 136 (1948).

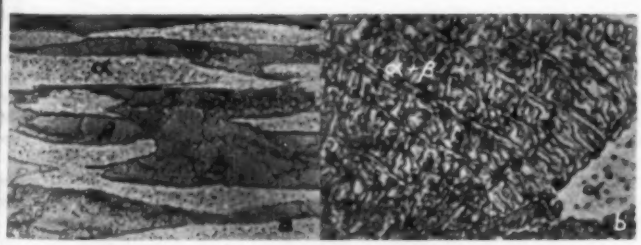


Fig. 1. Photomicrographs of silver–magnesium alloys annealed at 350° C.

(*a*) Slowly cooled alloy; β-phase almost fully recrystallized (× 680) (*b*) Quenched alloy; Widmanstätten structure in β-phase (× 2,100)

Elasticity and Rupture of Concrete and Stone at Constant Rates of Loading

Experiments have been made to study the elasticity and rupture of concrete and stone cubes of 4-in. side while being loaded to failure in compression in a testing machine. An ultrasonic pulse was propagated through the cubes and, at intervals throughout the loading, the time of transmission of the leading edge of the pulse was measured across the concrete. The pulse travels through the medium with a velocity (V) which is related to the elasticity by the relation:

$$V^2 = \frac{E\,(1-\sigma)}{\rho\,(1-2\sigma)\,(1+\sigma)}, \qquad (1)$$

where V is the longitudinal wave velocity, E the elasticity, ρ the density, and σ is Poisson's ratio for the medium.

The transmission times were measured to an accuracy of better than 1 per cent by a technique which has been described elsewhere[1].

Measurements of the longitudinal wave velocity were made vertically, in the direction of application of the load, and also horizontally across the cube. The piezo-crystal assemblies used for transmitting and receiving in the vertical direction were mounted in holes of $1\frac{1}{16}$ in. diameter by $\frac{3}{8}$ in. deep in two mild steel plates 7 in. square by $1\frac{1}{2}$ in. thick. These steel plates were then placed between the top and bottom faces of the cube and the plattens of the testing machine. In the horizontal direction a further pair of crystal assemblies was clamped across a pair of opposite faces of the cube.

Concrete Cubes. With increasing load the longitudinal wave velocity, measured vertically, remained sensibly constant up to failure. Thus from equation (1) the elastic modulus, as measured by infinitesimally small changes of dynamic stress, remains constant. Creep will no doubt occur and the actual strain will be of the form:

$$\text{strain} = \frac{\text{stress}}{E} + C(t), \qquad (2)$$

where $C(t)$ is the contraction due to creep, which depends upon the rate of loading[2].

In the horizontal direction the longitudinal wave velocity remained constant up to only a fraction of the ultimate failing load and thereafter decreased with increasing load. The decrease was attributed to internal rupture of the specimens along vertical planes. The load at which the decrease initially occurred was found to depend upon the age and type of concrete, but was independent of the rate of loading from 600 lb./sq. in. per min. to 5,000 lb./sq. in. per min. The percentage change in longitudinal wave velocity with load is shown in Fig. 1 for a concrete with mix proportions 1 : $1\frac{1}{2}$: 3/0·40 at ages of three to ninety days, and it will be seen that initial cracking occurred at about 35 per cent of the ultimate failing load.

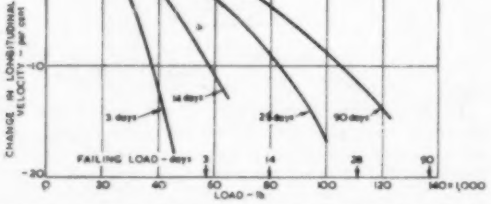


Fig. 1. Change in longitudinal wave velocity at right angles to direction of load in concrete cubes

The initial rupture and development of cracks in the concrete probably depend upon the stress distribution throughout the cube, which is affected by the contact conditions between the cube and the plattens of the testing machine. It is hoped to carry out further tests with rubber pads between the cube and the plattens to reduce the friction, and also on larger specimens in which failure occurs in a section having a uniform stress distribution.

Stone Cubes. Similar tests were made on 4-in. cubes of basalt and York stone. In the basalt cubes the longitudinal wave velocity, in the vertical direction, remained constant to beyond the start of internal rupture. At right angles to the direction of the load the longitudinal wave velocity remained constant to near the failing load before it began to decrease.

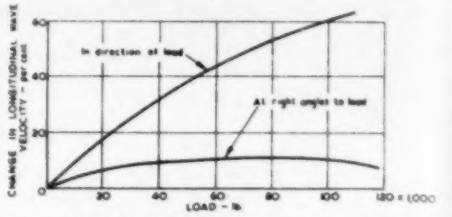


Fig. 2. Change in longitudinal wave velocity in York stone cube

With the York stone the longitudinal wave velocity, in the vertical direction, increased with load, as may be seen from Fig. 2. Such an increase in elasticity with load has been observed previously for porous rocks[3] and is attributed to the closing of the voids under load. At right angles to the direction of load the longitudinal wave velocity increased slightly until the onset of internal rupture.

The work described in this note was carried out at the Road Research Laboratory of the Department of Scientific and Industrial Research as part of the programme of the Road Research Board. The note is published by permission of the Director of Road Research.

R. Jones

Road Research Laboratory,
Harmondsworth, Middlesex.
July 28.

[1] Jones, R., *Mag. Concr. Res.* (in the press).
[2] Glanville, W. H., "Studies in Reinforced Concrete". III. "The Creep or Flow of Concrete under Load." Department of Scientific and Industrial Research, Building Research Technical Paper No. 12. (London: H.M. Stationery Office, 1930.)
[3] Zisman, W. A., *Proc. U.S. Nat. Acad. Sci.*, **19**, 653 (1933).

An Equal-Stepped Tuning in a Ganda Harp

There is a widespread impression that African music follows principles which are completely outside European tonal conceptions. Accurate data, however, which would enable students of exotic music to clarify this issue, are very rare. It is therefore of interest that it has been possible to demonstrate an equal-stepped pentatonic tuning in Uganda.

Apparatus. The apparatus used in the present study was a chromatic stroboscope, as described by Young and Loomis[1]. It offers the great advantage of accurate, rapid readings and of eliminating human prejudice in the identification of frequencies and the interpretation of intervals.

Musician. The African expert, Mr. Temuseo Mukasa, helped the author in musicological studies once before, in 1939. As a 'King's musician' at the court of the Kabaka of Buganda, as a pupil and successor to the late Mr. Jemusi Mayanja—the greatest harpist of them all—and as a musician of life-long experience on the bow-harp, he made a competent assistant well versed in the tradition of his art.

Musical instrument. The instrument was an 8-stringed harp without supporting pillar, of a design peculiar to Uganda. In this variety of harp the tension of the strings gives rigidity and strength to

the structure. Thus change in tension of one string is likely to act on the neck and affect its arch and alter the pitch of the others. Much of the harpist's time and attention is therefore given to tuning and to the maintenance of the strings, and an experienced player acquires great skill in this connexion. The strings are manufactured by a specialist, graded in thickness, and different methods of treatment are practised in order to obtain good service.

Tuning procedure. The harpist goes through the tuning process in three stages or operations.

(1) He begins with string No. 1, the highest note of the series. This is tuned, in Mr. Mukasa's case, to a note in the neighbourhood of *G*4 (*G* above middle *C*); this was found already to be his practice in 1939. Then string No. 2 is tuned at an interval with string No. 1 of roughly 240 Cents (1 Cent = 1/100th of a tempered semitone; $[1\,C = 1200/\log 2]$)[2]. It is rather important to have this interval fixed satisfactorily, because on its size depends the position of the following intervals. This process is continued with similar values step by step until string No. 8 is reached.

(2) It is difficult to check up on a tuning of this type where merely a traditional, memorized pattern can be drawn upon as norm. The following method is adopted in order to exercise some kind of control. Nos. 1, 2 and 3 are struck in quick succession, followed by Nos. 2, 3 and 4 struck in the same way, and so forth until the test is completed with Nos. 6, 7 and 8. All patterns are meant to be identical, merely based on a different string every time, and if the same series of intervals or the same impression is to be obtained from every one of the six test patterns, then all steps must be sufficiently equal to yield this result. It is in this sense that the term 'equal-stepped' is used.

(3) The third and last method employed to ensure a satisfactory tuning is the checking of the octaves. Nos. 1 and 6, 2 and 7, and 3 and 8 are intended to form octaves, and, indeed, Mr. Mukasa has been very successful in this task. The octaves deviate from the perfect interval by not more than 12, 2 and 8 Cents respectively. Good octaves are the hall-mark of the efficient tuner; in the case of a Uganda xylophone team, for example, adverse comment on the tuning of the instrument will immediately lead to vigorous testing of the octaves.

Table 1. Tuning values (calculated with the aid of tables in Young[2]) of an 8-stringed Ganda harp

Number of string	Frequency in cycles per sec.	Interval in Cents
1	405·82	
		250
2	351·25	
		245
3	304·90	
		244
4	264·82	
		235
5	231·29	
		238
6	201·51	
		236
7	175·83	
		239
8	153·16	

Tuning values. It will be seen from Table 1 that all seven steps are equal within a margin of 15 Cents. Mr. Mukasa did not always produce such regular intervals. On one occasion he tuned the first interval to 211 Cents and then corrected it to 227 Cents. On another occasion he produced an interval of 275 Cents for the second step, followed by 212 Cents to compensate for this excess and to fit the series into the framework of the octaves; he carried on with 252, 240, 228 and 245 Cents for the remaining intervals of the tuning. In one series of ten tunings, performed within one week, the mean for each of the seven intervals was remarkably close to 240 Cents (see Table 2). In the majority of unsatisfactory tunings, adjustments were made in the direction of this interval.

Table 2. Mean averages of ten tuning values of a Ganda harp

Interval between strings	Interval in Cents	
	Mean	$\pm\sigma$
1–2	239	15
2–3	254	17
3–4	238	12
4–5	240	8
5–6	236	10
6–7	240	11
7–8	229	14

Discussion. The preponderance of intervals of the type described in Table 1 is characteristic for harp and xylophone music in the kingdom of Buganda, an interval puzzling for a European ear inclined to interpret this strange pattern in more familiar terms of seconds and minor thirds.

The Uganda harp is usually played at such speed that no time is left for the sensation of chords and 'harmony'. Thus the kind of equal-stepped tuning observed need not create displeasure. It is noteworthy that the one exception where chords are struck is the octave, the only consonant interval in this system, which is also significant in European music.

In view of the care taken in tuning octaves, a European student might be tempted to expect some interest in fifths and fourths. However, the tuner pays no attention to them—unless the second tuning operation described above actually aims at fourths: two successive intervals in Table 1 may be said to suggest the interval of a fourth.

The same approach to tuning has been found in xylophone music in Uganda. Not only did the musicians show no response to the suggestion that their tuning might distinguish between intervals of different size, but also they clearly stated that they wished all steps to be the same.

It has been said that "the African is not thinking in terms of scales and intervals"[3]. One may well ask whether the equal-stepped tuning may not be due to this vacuum in the African musical mind, and whether it is possible that (*a*) when there is lack of concern in scales and chords, an equal-stepped pattern may emerge from a haphazard series of notes; (*b*) such a pattern might appeal to people in whose melodies the interval of the fourth is prominent.

This work was supported by the Colonial Social Science Research Council (Colonial Welfare and Development Scheme for Music Research R/233).

K. P. Wachsmann

Uganda Museum,
Kampala.
Aug. 6.

[1] Young, R. W., and Loomis, A., *J. Acous. Soc. Amer.*, **10**, 112 (1938).
[2] Young, R. W., "A Table relating Frequency to Cents" (C. G. Conn, Elkhart, Indiana, 1939).
[3] Howes, F., "Man, Mind and Music", 11 (Secker and Warburg, London, 1948).

FORTHCOMING EVENTS

Monday, January 9

INSTITUTION OF THE RUBBER INDUSTRY, MIDLAND SECTION (at the James Watt Institute, Great Charles Street, Birmingham), at 7 p.m.—Dr. C. F. Flint: "The National College of Rubber Technology".

Tuesday, January 10

SOCIETY OF DAIRY TECHNOLOGY (at the Conway Hall, Red Lion Square, London, W.C.1), at 10.30 a.m.—Mr. E. Capstick: "The Past 100 Years"; at 2.30 p.m.—Mr. Ben Hinds: "The Road Ahead".

ROYAL ANTHROPOLOGICAL INSTITUTE (in the Physiology Theatre, University College, Gower Street, London, W.C.1), at 5 p.m.—Prof. W. C. Osman Hill: "The Veddahs of Ceylon, their Physique and Environment".

INSTITUTION OF ELECTRICAL ENGINEERS, EDUCATION DISCUSSION CIRCLE (at Savoy Place, Victoria Embankment, London, W.C.2), at 6 p.m.—Discussion on "The Organization of Laboratory Work" (to be opened by Mr. J. G. Fleming).

INSTITUTION OF OFFICE MANAGERS, MERSEYSIDE BRANCH (at the Exchange Hotel, Liverpool), at 6.30 p.m.—Mr. W. J. Jolly: "Quality Control".

Wednesday, January 11

SOCIETY FOR APPLIED BACTERIOLOGY (at the Medical Society of London, 11 Chandos Street, Cavendish Square, London, W.1), at 10 a.m.—Winter Meeting; at 2.15 p.m. (joint meeting with the MICROBIOLOGICAL PANEL OF THE FOOD GROUP OF THE SOCIETY OF CHEMICAL INDUSTRY).—Discussion on "The Hygiene of the Preparation and Service of Food".

INSTITUTE OF FUEL, NORTH-WESTERN SECTION (at the Engineers' Club, Albert Square, Manchester), at 2 p.m.—Mr. A. Ridings: "Considerations affecting the Choice and Design of Boiler Plant".

GEOLOGICAL SOCIETY OF LONDON (at Burlington House, Piccadilly, London, W.1), at 5 p.m.—Dr. J. E. Prentice: "The Carboniferous Limestone in the Manifold Valley, North Staffordshire"; Mr. A. Ludford: "The Stratigraphy of the Carboniferous Rocks of the Weaver Hills District, North Staffordshire".

ROYAL MICROSCOPICAL SOCIETY (in the Hastings Hall, B.M.A. House, Tavistock Square, London, W.C.1), at 6 p.m.—Dr. Vera Fretter: "Minute Gastropods, Free Living and Parasitic".

CHEMICAL SOCIETY, EIRE SECTION (in the Department of Chemistry, University College, Dublin), at 7.45 p.m.—Prof. E. R. H. Jones: "Some Problems in the Chemistry of Vitamin D".

INSTITUTION OF THE RUBBER INDUSTRY, WEST OF ENGLAND SECTION (at the George Hotel, Trowbridge), at 7.45 p.m.—Mr. Geo. Martin: "Developments in the Plantation Industry".

Thursday, January 12

CHEMICAL SOCIETY, ST. ANDREWS AND DUNDEE SECTION (in the Chemistry Department, University College Dundee), at 5 p.m.—Mr. R. P. Bell, F.R.S.: "Keto-Enol Equilibrium".

ROYAL SOCIETY OF ARTS, INDIA, PAKISTAN AND BURMA SECTION (at John Adam Street, Adelphi, London, W.C.2), at 5.15 p.m.—Mr. H. W. Tilman: "The Mountains of Sinkiang—Travels beyond the Himalaya in 1948".

INSTITUTION OF ELECTRICAL ENGINEERS (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Mr. J. E. N. Hooper and Mr. A. A. Kippax: "Radar Echoes from Precipitation". (Members of the Royal Meteorological Society are invited.)

ILLUMINATING ENGINEERING SOCIETY, MANCHESTER CENTRE (joint meeting with the MANCHESTER AREA BRANCH of the ELECTRICAL CONTRACTORS' ASSOCIATION, in the Reynolds Hall, College of Technology, Manchester), at 6 p.m.—Mr. F. G. Copland: "Analysis of Lighting Problems in an Industrial Undertaking".

PHARMACEUTICAL SOCIETY (at 17 Bloomsbury Square, London, W.C.1), at 7.30 p.m.—Dr. J. M. Rowson: "Genetics, Cultivation and Pharmacognosy".

Friday, January 13

ROYAL ASTRONOMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Scientific Papers.

INSTITUTION OF ELECTRICAL ENGINEERS, WESTERN CENTRE and WEST WALES (SWANSEA) SUB-CENTRE (at the Brangwyn Hall, Swansea), at 6.30 p.m.—Dr. R. A. Smith: "Radar" (Faraday Lecture).

INSTITUTION OF WORKS MANAGERS, MANCHESTER BRANCH (at the Engineers' Club, Albert Square, Manchester), at 6.30 p.m.—Miss Joan Woodward: "Some Problems of the Physical and Psychological Environment of Work".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

ADVISORY OFFICER IN GRASSLAND HUSBANDRY, a RESEARCH ASSISTANT IN MILK UTILIZATION, and a TECHNICAL ASSISTANT to the Advisory Officer in Animal Husbandry—The Secretary, West of Scotland Agricultural College, 6 Blythswood Square, Glasgow, C.2 (January 14).

SENIOR LECTURER IN ELECTRONIC ENGINEERING or RESEARCH FELLOW IN THE DEPARTMENT OF ELECTRICAL ENGINEERING, University of Adelaide—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (January 16).

CHEMIST (Senior Scientific Officer or Scientific Officer grade) and a CHEMIST (Senior Experimental Officer or Experimental Officer grade) at a Ministry of Supply research and development establishment in London for work on safety measures and other research problems connected with industrial use of explosives and high pressure acetylene—The Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting F.883/49A (January 21).

ASSISTANT LECTURER IN PAPER MAKING—The Registrar, College of Technology, Manchester 1 (January 23).

SENIOR VETERINARY OFFICER at the Institute of Medical and Veterinary Science, Adelaide—The Agent General and Trade Commissioner for South Australia, Marble Arch, London, W.1 (January 23).

PRINCIPAL GEOLOGIST at the Central Directorate of the Colonial Geological Surveys, Imperial Institute—The Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting G.422/49A (January 28).

LABORATORY MANAGER OF THE JOHN CURTIN SCHOOL OF MEDICAL RESEARCH, Canberra—The Administrative Officer in the U.K., Australian National University (London Office), 6 Gordon Square, London, W.C.1 (January 31).

RESEARCH ASSISTANT to the Professor of Colour Chemistry and Dyeing—The Registrar, The University, Leeds (January 31).

SCIENTIST (Grade III) IN THE DIRECTORATE OF SCIENTIFIC CONTROL, to carry out operational research—The National Coal Board, Establishments (General) Branch, Hobart House, Grosvenor Place, London, S.W.1, endorsed TT/180 (January 31).

CHAIR OF AERONAUTICAL ENGINEERING, and a HEAD OF THE ENGINEERING DEPARTMENT and PROFESSOR OF MECHANICAL ENGINEERING—The Registrar, University College, Southampton (January 31).

LECTURER IN GEOGRAPHY—The Registrar, The University, Reading (February 1).

LECTURER or ASSISTANT LECTURER IN CHEMISTRY at the University College of the West Indies—The Secretary, Inter-University Council for Higher Education in the West Indies, 1 Gordon Square, London, W.C.1 (February 11).

SENIOR LECTURER IN AGRICULTURAL OR CHEMICAL MICROBIOLOGY at the University of Melbourne—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (February 11).

SENIOR LECTURER IN BACTERIOLOGY at University College, Ibadan—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W.C.1 (February 11).

CHAIR OF AGRICULTURE in the University of Ceylon—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (February 15).

PHYSICISTS (Scientific Officer grade) at Ministry of Supply Research and Development Establishments in Southern England and South Midlands—The Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting A.325/49A (February 20).

PROFESSOR OF AGRICULTURE—The Secretary, Imperial College of Tropical Agriculture, 40 Norfolk Street, London, W.C.2, or The Registrar, Imperial College of Tropical Agriculture, St. Augustine, Trinidad, B.W.I. (March 31).

ENTOMOLOGIST for the Malaria Service of the Medical Department, Nigeria—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1.

PLANT PHYSIOLOGIST to carry out research work on natural rubber latex—The Director of Research, British Rubber Producers' Research Association, 48 Tewin Road, Welwyn Garden City, Herts.

RESEARCH ASSISTANT (preferably A.R.I.C. standard) to work on the analysis of a wide range of non-ferrous alloys, including development of new analytical methods, and a PHYSICIST to work on spectrographic analysis of metals—The Secretary, British Non-Ferrous Metals Research Association, 81–91 Euston Street, London, N.W.1.

RESEARCH TECHNICIAN to assist in experiments connected with the origin and treatment of cancer—The Dean, Guy's Hospital Medical School, London, S.E.1.

SENIOR ENTOMOLOGIST and a JUNIOR ENTOMOLOGIST (with good honours degree in Zoology) for entomological research with special reference to East African conditions, and a RESEARCH OFFICER for spectrographic work on soils and plant materials, in the East African Agriculture and Forestry Research Organization—The Under-Secretary of State, Colonial Office (Research Department), Sanctuary Buildings, Great Smith Street, London, S.W.1.

SOIL PHYSICIST IN THE DEPARTMENT OF AGRICULTURE, Sierra Leone, for investigations in connexion with the reclamation, drainage and cultivation of paddy rice on very acid soil—The Director of Recruitment, Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1.

LECTURER IN MATHEMATICS—The Clerk to the Governing Body, Battersea Polytechnic, Battersea, London, S.W.11.

RESEARCH PHYSICISTS—The Secretary, Research Association of British Rubber Manufacturers, 105 Lansdowne Road, Croydon, Surrey.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

University of Leeds. Thirty-sixth Report, 1946–47. Pp. 34. Thirty-seventh Report, 1947–48. Pp. 39. (Leeds: The University, 1948–1949.) [3110

Scottish Home Department: Fisheries Division. Scientific Investigations, 1949, No. 1: The Distribution of Thaliacea (Salps and Doliolids) in Scottish Waters, 1920 to 1939. By Dr. James H. Fraser. Pp. 44. (Edinburgh and London: H.M. Stationery Office, 1949.) 2s. net. [3110

Department of Scientific and Industrial Research. Index to the Literature of Food Investigation. Vol. 17, No. 2, September 1945. Compiled by Agnes Elisabeth Glennie. Pp. iv+105–181. (London: H.M. Stationery Office, 1949.) 6s. net. [3110